

NOVEMBER 1922

Vol. LXXVI

NOVEMBER, 1922

No. 5

ANNALS of SURGERY

A Monthly Review of Surgical Science and Practice

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THE TREATMENT OF CHRONIC EMPYEMA WHERE THE RECOGNIZED SURGICAL PROCEDURES HAVE FAILED TO PRODUCE OBLITERATION

BY WILLIAM L. KELLER, M.D.

LIEUT. COLONEL, MED. CORPS U.S.A.

WHEN the crest had been reached in the treatment of strictly post-war surgery and the number of this type of case had begun to wane, the Army found itself confronted with a large number of chronic empyema cases, the residue of the well-remembered influenza epidemic of 1917 and 1918. All the time-honored and well-recognized measures of treatment, though applied with consummate skill and untiring patience by many of the ablest surgeons in the country, went unrequited so far as this particular group of unfortunates was concerned, and so we had confronting us then a forlorn lot of surgically scarred individuals who had seen many a bitter day of sorely tried hopes as one operative procedure after another had failed them. The mere conventional valuation of life would have been incentive enough had not the humane element actuated us to attempt some method other than the ones which had already spelled failure. We were fully cognizant of the complex and diverse aspects of the problem, yet our aim was to discover in this great mass of contradictory operative procedures and end results, the reason or reasons for failure. This accomplished, it would then become our duty to effect a cure and at the same time be prepared, if necessary, to controvert opposing opinions. The principal motive in acting then was with this hypothesis in mind, and so we set resolvedly to the task, but with a determination not to be tempted into foolhardiness. All the patients in question were poor surgical risks, depleted both in mind and body, and any surgical attempt at repair had to be done, step by step, but never until the full confidence of the patient had been gained.

A previous experience of some seven years ago first led me to believe in the wisdom of the "open type" of operation as both the logical and surgical method to pursue. At that time, I was attempting to do a partial decortication on a patient who had had five previous operations for chronic empyema, when the hemorrhage encountered became so profuse that it was necessary to clamp the bleeding points, leave the clamps in position and pack the remaining cavity. This, of course, was in the pre-Dakin days, but subsequently, I was astonished to see the ease with which the antiseptic solution could be applied directly to every recess of the cavity, the rapidity with

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which the cavity became clean, and the promptness with which it was afterwards obliterated. That the obliteration was permanently successful is evidenced by the fact that this patient, an officer, has remained constantly on active duty since the time in question, and in the meanwhile served in France throughout the strenuous days of the World War.

It seemed but logical then that these very same conditions should be simulated in the treatment of the post-influenzal cases of chronic empyema if a very resistant type of organism, the haemolytic streptococcus, is to be rendered inert and that through the agency of a most valuable adjunct in the treatment of such cases—the Dakin solution—which had been placed in the hands of the surgeon as one of the scientific triumphs of the World War.

From such a beginning as this did the present type of "open operation" then evolve, being elaborated from time to time by the operator as the occasion arose to meet and overcome new conditions and complications.

In this paper I want to deal especially with the cases which have resisted all the well-recognized surgical procedures and have subsequently fallen into my hands for treatment and final disposition. In this connection, I want to enumerate briefly the predominating etiological factors which have been brought forcibly to my attention in the observation and treatment of such cases. Among their number, 60.8 per cent. presented pleurobronchial fistulae; 90 per cent. had osteomyelitis of the ribs with or without sequestration; 75 per cent. showed accessory pockets or diverticulae; 15 per cent. foreign bodies in the nature of rubber tissue, drainage tubes or bismuth paste; 100 per cent. had haemolytic streptococcus as the causative organism and 15 per cent. had underlying constitutional conditions such as tuberculosis and syphilis.

Our aim therefore is to obliterate these cavities by a method which will produce the minimum mutilation, increase vital capacity and lower mortality. To us the "open" many-stage operation approaches closer to this ideal than any other method that we know.

Inasmuch as the previous methods of operative procedure in the hands of competent surgeons, when the patients were better able to withstand operative trauma and overcome their infections, had failed, it seemed that some operation should be attempted which would obviate these causes for failure in the past, and, at the same time, be well within the limits of safety by minimizing shock.

It was obvious that these patients could not withstand an extensive operation. They presented suppurating cavities, and since resected ribs projecting into such a cavity may or may not go on to osteomyelitis with sequestration, it seemed as though the logical procedure to follow was to lay the cavities completely open for direct Dakinization and visual inspection at all times.

The reason for this open type of operation was made more apparent when it was realized that a large percentage of cases of chronicity and recurrence were due to diverticulae, unnoticed at the time of operation, draining by minute sinuses into the main cavity, or in some cases to an unobliterated and infective pocket, usually lying anteriorly or posteriorly to the main cavity, which failed to close when obliteration of the greater part of the cavity

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occurred, either by re-expansion of the lung or by collapse of the chest wall. It was determined early in our observations that the pleurobronchial fistula was a major factor in producing chronicity, and it became apparent that any attempt at closure of these fistulae in a septic field was useless and dangerous.

With these complications playing such a prominent part in the chronicity of this condition, it was deemed necessary to attempt some operative procedure which, from the very nature of the technic itself, would obviate any and all of these factors and, at the same time, permit a patient with low vital capacity and little resistance to undergo the necessary surgical treatment and, at the same time, have the accompanying shock reduced to a minimum.

Since the complete procedure could not be done at one time with safety to the patient, a fractional or step-like operation was adopted in which no previous step would be nullified by the lapse of time intervening between the subsequent phases.

At this point I wish to emphasize the fact that these patients were not improving. For three or four years the majority of them had maintained their cavities and had continued to discharge pus from them. By the marked thickening of the parietal pleura, Nature had apparently accomplished as much obliteration as possible, but despite her efforts, there still remained an appreciable cavity with a collapsed and non-functioning lung and a pleurobronchial fistula in 60.8 per cent. of the cases.

All these patients require some form of operation that would give them a complete cure; consequently postponement was out of the question, for as time elapsed, they would continue to grow progressively worse and become poorer surgical risks. It was therefore necessary to take the case in hand before some secondary condition intervened to snuff out what little vitality remained. Furthermore, from the economic standpoint alone, an operation of this character was justified, for if hospitalization could be terminated, and the patient healed and restored to at least a fraction of his former earning capacity, he became an asset rather than a liability to the community.

With all the foregoing requisites, the following plan of procedure was ultimately adopted:

During the pre-operative treatment, the patient, after being admitted to the Empyema Service, is placed on a high caloric diet; cultures from the cavity are sent to the laboratory to ascertain the organisms present; routine laboratory examinations of the blood, including red, white, and differential counts, together with estimation of the haemoglobin, are made; the Wassermann reaction is taken; urinalyses are made; the sputum examined for tubercle bacilli; the blood chemistry determination is made when indicated and the vital capacity determined. Preliminary Dakinization of the cavity for a few days prior to the operation is carried out in order to cleanse it and, at the same time, to render the patient less septic, while in the interim, careful blood-pressure readings are made. The patient is typed and his blood checked against that of the prospective donor for agglutination and haemolysis. A high compound enema is given at 6 A.M. on the morning of

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the operation and no breakfast; morphine sulphate grain $\frac{1}{4}$ and atropin sulphate grain $1/150$ are administered in the ward one and one-half hours before operation. One-sixth of a grain of morphine sulphate is given thirty minutes before the operation is actually begun. Paravertebral anaesthesia is instituted by using one-half per cent. novocain solution and this is combined with superficial and deep infiltration anaesthesia in the region of the operation. Nitrous oxide and oxygen are subsequently given to the point of analgesia only, which procedure in addition to relieving pain also serves the double purpose of allaying fright and rendering the patient less susceptible to his surroundings, thereby eliminating one of the elements in the production of shock. A pre-operative transfusion is done in cases that are markedly septic and greatly emaciated.

As concerns the operation itself, in our first cases, provided simple and dependent drainage existed, the usual procedure was to attack the uppermost portion of the cavity first; otherwise the lowermost portion of the cavity was exposed in order that effective drainage could be established at the earliest possible moment. In all our recent cases, it has been the policy to attack the cavity at its lowest part and this has proven a most satisfactory method of approach.

An incision is made over that portion of the cavity which it is desired to expose and which, after outlining its limits with bismuth paste, has been previously located with accuracy by the X-ray; the skin and superficial tissues having been incised and hemorrhage controlled, the superficial muscle layers of the chest are now exposed. Large forceps are used to clamp the muscle bodies before they are severed, thereby eliminating all hemorrhage which might arise from them. Each rib is detached from the immediate musculature for two or three cm. beyond the extent of the cavity on either side after the surrounding tissues have been infiltrated with one-half per cent. novocain solution, and the main portion of the rib is separated subperiosteally, but it is imperative that the subperiosteal separation does not extend to the point where the rib is to be divided, *i.e.*, it should stop a half inch from the point of rib section. In the presence of infection which has been found in one hundred per cent. of these cases, it is advisable to avoid subperiosteal resection at the point of rib division for the following reasons: (1) As has already been stated, osteomyelitis is present in 90 per cent. of these cases, with or without sequestration, and in almost every instance, it proved to be the "cut end of the rib" for one-half to three-fourths inch beyond the point of resection, which sequestration after one of the former operations done, as all such cases usually are, by the well-recognized subperiosteal method. These infected rib ends subsequently become detached and are displaced into the pleural cavity, either by muscle movement or pressure of the skin or scar tissue contracting over the site of the former operations, where they in turn become secondary foci of infection. (2) Again it has been demonstrated repeatedly during the war and afterwards, that the Bunge amputation which calls for the removal of the periosteum one-fourth inch above the

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point of division of the bone, is invariably followed by sequestration when the bone is denuded to this extent, and even simple periosteal separation is also frequently found to be followed by similar results, especially in cases for re-amputation where there had been prolonged suppuration at some previous time. Consequently the periosteum is cut flush with the rib on section and no sequestration has been seen so far in any of the cases where this method has been followed. Realizing the added difficulty which this procedure involves, since hemorrhage is much greater here than where subperiosteal resection is practiced, every effort should be made to control the vessels in the vicinity of the ribs to be sectioned before they are cut through.

It must be apparent to all who have operated on this type of case that the onset of shock is usually simultaneous with the resection of the overlying bony structure of the chest wall. Therefore, at this stage of the operation, the anæsthetist is instructed to make careful readings of the systolic and diastolic blood-pressure and closely observe the pulse-rate and general condition of the patient at ten-minute intervals or less, reporting the same to the operator. We have made it an infallible rule to use this as a guide or check on the amount of operative procedure to be undertaken at any one step. When the systolic pressure drops to 90 mm. of mercury, the operation is discontinued at once, even if the general condition of the patient is good and the pulse-rate within the limits of safety, since experience has shown that in some cases a subsequent drop of ten to twenty mm. will occur, during the first hour or two after operation.

Having resected the bony structures overlying that part of the cavity to be exposed in this step of the operation, the parietal pleura is next incised and that portion of the cavity you are particularly interested in is now exposed to view. It is but a natural inclination for the operator to do as much as possible at one time, provided the patient's life is not being endangered, but on two occasions during the first operations in this series, when we thought that we were completely within the limits of safety, the patients rapidly passed into profound shock and died, although they had been on the table less than forty minutes. After such an experience, the value of brief and repeated operations was forcibly brought home to us. The cavity having been exposed to the extent desired, the skin is inverted over the severed muscle and anchored together with the muscle over the resected rib stumps by means of silkworm gut sutures. The object in doing this is to prevent the muscle and skin, which are necessary for the final closure, from retracting and becoming atrophied, and also to render the dressings less painful, since the sensitive areas are now covered with skin as a protecting covering as shown in Fig. 1.

Multiple sacrifice is practiced on that portion of the skin sutured under tension to cause relaxation and to prevent sloughing. The dressing is then applied after eight to ten Carrel tubes are placed in the cavity in layers, interspersed with gauze, and the whole area gently packed in this fashion, while one Carrel tube is placed under each infold of the skin and muscle for forty-eight hours. The outer dressings are now applied and the patient, if his condition warrants, is removed to the recovery room. Should

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his condition not warrant disturbance or removal, he is allowed to remain on the table and active restorative measures are promptly instituted to combat shock. These consist principally in the local application of heat, the administration of a shock enema composed of spiritus frumenti 60 c.c. and coffee 120 c.c. and the elevation of the foot of the table. While these measures are being carried out, normal salt solution is administered intravenously, while another assistant obtains blood for transfusion from the donor, who has been checked against the patient prior to operation and who is waiting

in the next room. The citrate method is employed and the blood is given to the patient through the same apparatus that is being used to administer the normal saline. If a second fall in blood-pressure occurs and the symptoms of shock still persist, another transfusion is given. However, this post-operative phase of shock should occur but rarely if the surgeon will only adhere to the fixed principles of the step-like operation. Only two cases in this entire series required a second transfusion.

All danger of shock being over, the patient is returned from the recovery room on the day fol-

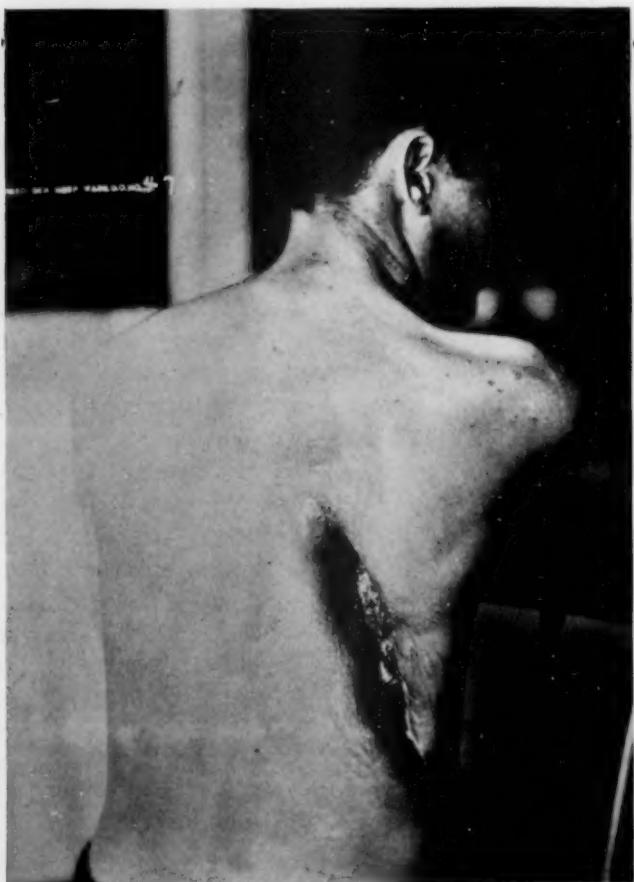


FIG. 1.—Showing turning in of skin to protect wound edges.

lowing the operation to his respective ward. It is imperative that the ward surgeon who daily dresses these cases should be present at the operation so that he may be fully informed of the particular complications that existed and will understand the objective to be reached as well as the complications that may ensue. The routine treatment adopted in the post-operative care of these cases is the classical Carrel-Dakin technic em-

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ployed in the sterilization of all septic wounds. The number of tubes depends upon the size of the cavity (Fig. 2). The cavity is then packed throughout its entire extent to prevent any overhanging of wound margins. It is important indeed that no portion of the exposed cavity be roofed over at any time by the encroachment of the contracting soft tissues or by unhealthy granulations. The dressings are changed daily, at which time the wound is thoroughly flushed out with Dakin's solution and the packing then reapplied.

As soon as the patient's general condition has improved to the point where operative procedure is warranted, he is again prepared in the manner described and more of the contiguous structures overlying the cavity are attacked. This procedure is continued until eventually the cavity is laid wide open in its entirety. In some instances there have been as many as five subcavities detected; most of them were missed by X-ray and not seen in former operations because of their very minute openings which would admit only the smallest probe, yet these openings led to cavities that held



FIG. 2.—Showing placing of tubes for Carrel-Dakin technic, from 15 to 50 c.c., but were not made evident until after they had been Dakinized for ten days or two weeks. (Fig. 49.)

The collapsed lung is mobilized from its fibrous pleural covering in two ways, depending usually upon the character of the fibrous deposit in the thin-walled haemolytic streptococcus pleura, too adherent to permit a line of cleavage, the lung is freed by the application of a two per cent. alcoholic solution of gentian violet in the form of a pack. This is applied for two

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consecutive days, after which the cavity is re-sterilized by the constant application of Dakin's solution until the entire blue coating of devitalized tissue has exfoliated, when a second application of the gentian violet is made, if necessary. This solution has also been used in very thick pleuræ, but the action is slower except when employed in conjunction with dissection. On our first cases this agent was used for three consecutive days, but it was soon discovered that the destructive action led to the breaking down of the superficial air cells and lung herniation which was alarming in one case. There was rupture of the pleura in a second case and hemorrhage in a third, so consequently this dye should be used with great care and never in this strength, except in the open type of operation. The other method of pulmonary mobilization practiced has been a dissection after the method of Ransohoff in preference to surgical decortication, which is usually employed shortly before closure and sometimes in the wards without anæsthetic or pain to the patient.

Surgical decortication was practiced in some cases but it was found that the expansile power of the lung was lost much earlier than where the chemical decortication was practiced. By these methods, cavities of 500 c.c. have been reduced to 50 c.c., but these or any other methods of decortication will not produce expansion in a lung that has undergone fibrosis.

The cavity formerly of large capacity having been reduced to a minimum by expansion of the lung and when possible after seven consecutive sterile cultures have been obtained, is now ready for closure. It has been necessary, however, to close some cases where it was found impossible to get as many as seven consecutive sterile counts and the result so far in each case has been satisfactory and the treatment exactly the same, except that the temporary drainage was allowed to remain for an extra twenty-four hours. Several other factors also enter into the obliteration of these cavities, and regardless of what has been written relative to the diaphragm on the affected side not ascending in the presence of dense adhesions, it does occur. The other lung also tends to push over into the inadequately filled pleural space of the affected side and in this way helps to obliterate the cavity even when the mediastinum is fairly rigid. Granulation is also a factor in reducing the size of small cavities.

The subsequent closure of these empyema cavities can be accomplished in progressive phases if it is deemed necessary and in the same manner that a graded method was used to expose them. But before taking up in detail the technic of plastic closure, the closure of bronchial fistula deserves special mention, as this complication has proven one of the most intractable of all to eradicate. The fallacy of attempting to close these fistulae in the presence of sepsis requires further emphasis, and even in the presence of repeated sterile cultures it is a question if it is always advisable to completely close any fistula in cases of this type, for even then one cannot be certain as to the complications which may arise; even in the hands of capable surgeons, closure

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has been followed by such disastrous complications as lung and brain abscesses. In this connection, it might be well to mention, and it is probably fortunate too, that there is no absolutely reliable way by which every bronchial fistula can be closed. While the recognized method of purse-string suture with inversion will close some, it has been found in our experience that it is far more satisfactory to reduce the size of the bronchial fistula by surgical means such as partial suture and to allow it to close by granulation after stimulating local applications of two per cent. alcoholic solution of gentian violet. Some of our early cases were closed by suture and implantation of muscle over the closed fistula which was afterwards safeguarded by a Carrel tube left in the vicinity of the closure for forty-eight or seventy-two hours. Although this method is not advocated as being ideal, it is far less dangerous than the implantation of a skin flap which forms a much more resistant barrier in the event complications arise, as they often do, even in the hands of competent surgeons. Our greatest success in the closure of fistulae has been through a combination of procedures which includes the mobilization of the lobe containing the fistula in the area in which the fistula emerges on the surface of the lung, and the local application of gentian violet as described above or the partial reduction of the size of the fistula by suture subsequently followed by the application of gentian violet. The actual cautery was used in some cases, but with success only in those very minute fistulae which did not need much treatment. It is absolutely imperative that no attempt at final closure of the remaining cavity be made while a patent pleuro-pulmonary communication exists. Through such an opening the pathogenic bacteria constantly present in the upper air passages naturally find ready access to more susceptible overlying soft tissues, thereby causing continuous reinfection. This, in our opinion, is the explanation for the failures which occur in some of the other operative methods.

Having progressed thus far in the treatment of the case, and having eliminated all the elements concerned in its chronicity, the patient is now ready for plastic closure and is prepared for operation as stated before. Local anaesthesia with gas analgesia is again used, the skin is freed from the underlying muscle bodies and undermined to the required extent. The muscles which have been saved at the previous operation are sufficiently freed from their attachment to allow complete re-suturing over the remains of the cavity. All the muscle tissue necessary is utilized to obliterate the space and the remaining severed muscles are brought in apposition by sutures, restoring as far as possible the normal contour of the chest wall and producing flexibility with movable skin surface in all cases except where the muscles were destroyed by previous operations and infection. During the dissection for liberation of the skin and muscles, preliminary to final closure, all raw surfaces are kept covered with moist Dakin packs to check oozing and to maintain sterilization. The skin edges and underlying muscle structure are approximated by a figure of eight silkworm gut suture, after all the

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FIG. 3.—Group showing marked deformity and rigid chest walls.

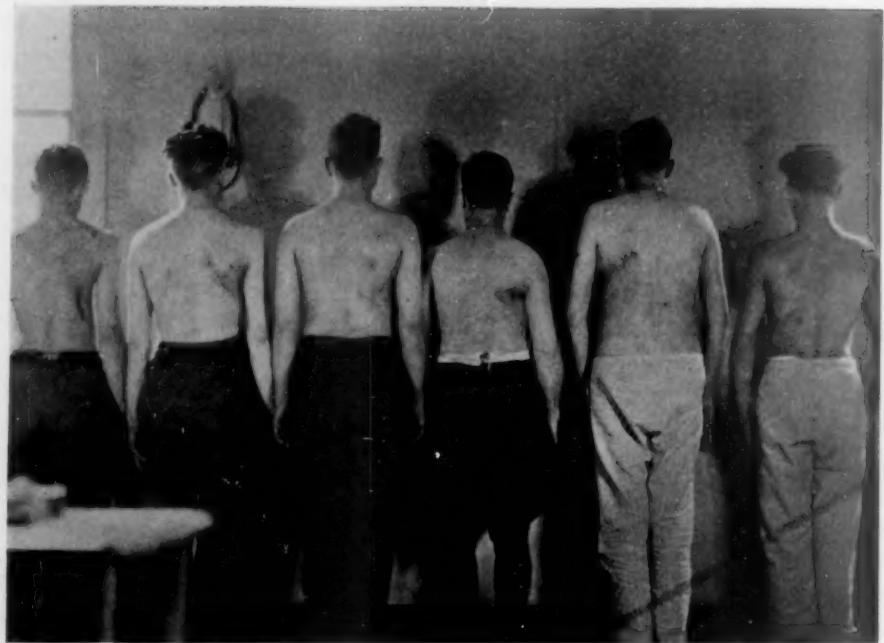


FIG. 4.—Group with no post-operative deformity and with flexible chest walls.

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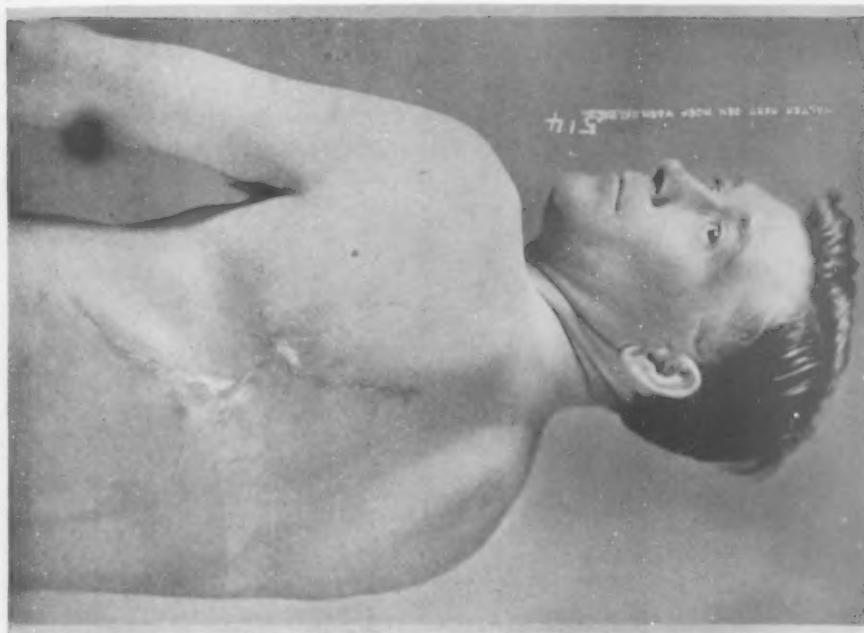


FIG. 5.—Showing general flexibility of chest and lack of deformity.

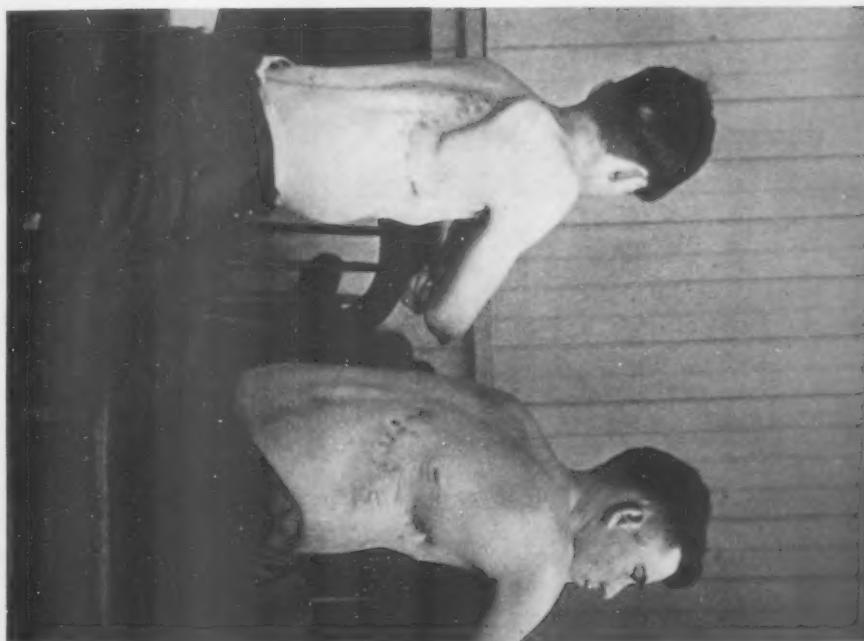


FIG. 6.—Showing general flexibility of chest and lack of deformity.

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redundant scar tissue has been excised. Rubber dam and Carrel tubes are inserted along the line of sutures to allow for drainage, and multiple scarification of the skin is again resorted to wherever it appears that tension is interfering with the proper circulation of the part. The dressings are firmly applied to prevent the occurrence of any spaces between the contiguous layers of tissue and at the same time assist in obliterating the cavity.

Whenever the cavity is of sufficient size to render a complete closure impossible at one operation, an attempt should be made to close only the

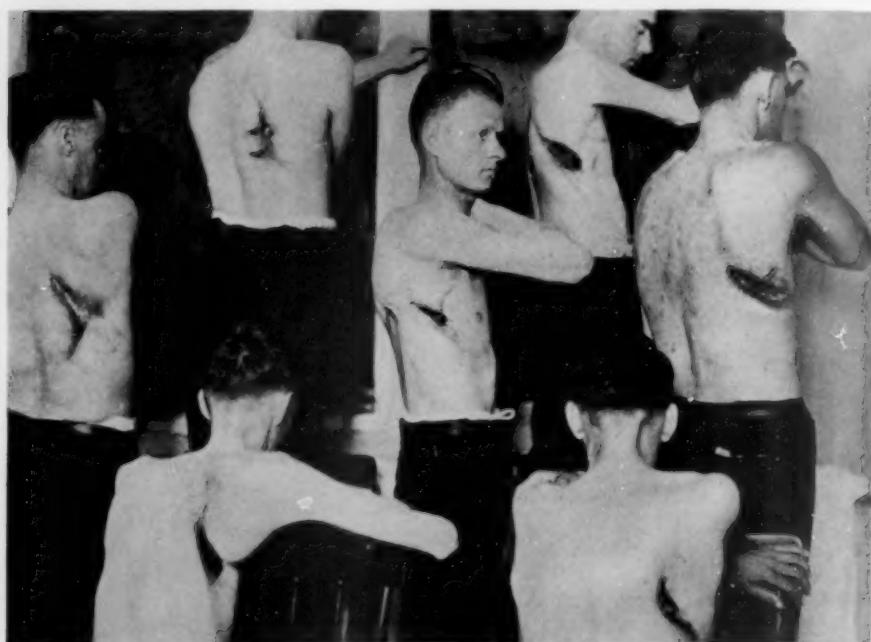


FIG. 7.—Group showing flexible chest walls with but little deformity.

uppermost aspect of the cavity in this manner, leaving the remainder to be closed at subsequent operations. The Carrel tubes are removed in twenty-four hours; the rubber dam drainage in forty-eight hours and the sutures in seven days.

The following classification, based on the condition of the patients when admitted to the Empyema Service, is presented for convenience of description.

Group I. Patients belonging to this group present great post-operative deformities, moderate-sized cavities with a capacity of 300 to 500 c.c.; osteomyelitis of the ribs, rigid chest walls and diminished vital capacity due to the compression of fibrosis of the lung or both. (Fig. 3.)

Group II. No post-operative deformity is found in these cases and only moderate-sized cavities of 300 to 500 c.c., while at the same time the chest walls are flexible and the lung tissues capable of ready expansion when liberated from the resistant thick pleura. (Figs. 4, 5 and 6.)

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Group III. This group is characterized by no post-operative deformities, but presents enormous cavities varying in size from 1000 c.c. to the entire capacity of the side involved. Collapsed lung with fibrosis is always present as is a rigid chest wall, the result of cross-union due to osseous regeneration on the part of the ribs.

Group IV. No post-operative deformities and only small cavities with flexible chest walls and expansile lung tissue. (Fig. 7.)



FIG. 8.—An irregular group. The upper row showing very little deformity. The middle and lower rows moderate deformity.

Irregular Group: The upper row of the cases in this class have very little post-operative deformity. The middle and lower rows moderate post-operative deformities due to rib resection and osteomyelitis before admission. (Fig. 8.)

Owing to the fact that such a large percentage of these cases have complications such as osteomyelitis, bronchial fistulae, secondary cavities, and multiple draining sinuses, they are not mentioned in the above groups, nor are they used as a basis for a more intricate classification of this condition.

Naturally some modification of the technic described is necessary usually to meet the exigencies of the type of case undergoing treatment.

In the treatment of cases belonging to Group I, where the deformity and destruction is so great that there is little or no available muscle tissue and the lung has undergone fibrosis, the existing deformity must perforce of circumstances be allowed to remain, but the empyema cavity itself is laid open. The

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bronchial fistula are closed preferably by mobilization of the involved lung or by local applications, except in the case of a very large fistula which can be reduced in size by partial closure and afterward completely closed by local applications of gentian violet by a small applicator eliminating all dangers incident to sudden surgical closure of these fistulæ. The extreme cases in this group show no marked improvement in the vital capacity following operation.

In cases belonging to Group II, the entire cavity is laid wide open by the many-stage operation and after the closure of all bronchial fistulæ and decortication, the cavity is obliterated by expansion of lung and later closure effected according to the technic already described. The greatest number of chronic empyema cases belong in this group and they should have a flexible chest wall and practically no deformity following operation.

In the cases of Group III, when the entire lung is collapsed and bound down, the existing openings are enlarged to remove involved ribs and to permit direct Dakinization of the cavity as well as to provide for more dependent and better drainage. After all sinuses are laid open and sterilized, every effort should first be made to expand the lung by chemical decortication and discussion. After the maximum expansion is obtained by the above methods, the remaining cavity is obliterated by some modification of the Wilms or Sauerbruch operations, provided all infected and necrosed ribs have been removed.

In cases belonging to Group IV, little if any treatment is necessary other than Dakinization after the cavity is laid widely open and the fistulæ closed, except plastic muscle closure following sterilization of the cavity.

It should be mentioned here that every effort is made to get these patients out of bed as soon as possible after each operation, usually on the second or third day.

Further after-treatment is as follows: The patient is kept on a high caloric diet, his weight is recorded at weekly intervals, and daily calisthenics in the nature of deep breathing exercises are instituted after healing has occurred.

Vital capacity readings are made on these cases following the closure and checked against the readings made on admission. It is interesting to note that there is a gain of anywhere from 500 to 1500 c.c. in lung capacity, which increase, I feel, is of decided importance to the patient as an evidence of heightened resistance to respiratory infections, a fact further substantiated by the sense of physical well-being experienced by these patients and a gain in weight varying from ten to forty pounds.

In our series of forty cases reported here, twenty-one were of from three to four years' duration; five were of two years' duration, and the remaining number varied from six to eighteen months.

Twelve of this number had radical operations of the most extreme form and twenty-four had multiple thoracotomies with removal of one or more ribs when admitted.

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The results in the series were as follows: Thirty-five closed; three died; one left hospital before ready for closure; one undergoing syphilitic treatment and ready for closure. One hundred and seventy-three operations were necessary to complete the work on these cases by the many-staged method.

In another series of over twenty cases recently admitted from the Veterans' Bureau, the time necessary for the completion of the treatment promises to be much shorter.

CONCLUSIONS

1. The chronic type of empyema, especially those with large cavities, should occur but seldom if early aspiration followed by negative pressure treatment is promptly instituted.

2. Empyema cavities can be obliterated by dissection and chemical decortication plus implantation of certain muscle bodies.

3. The patient's vital capacity and resistance to intercurrent disease can be increased by complete eradication of infection and the methods of decortication already mentioned.

4. Chemical decortication, if used injudiciously, may result in rupture of the visceral pleura, dangerous herniation of the lung, and hemorrhage, but the expanded lung retains its expansive power longer than when surgical decortication is practiced. (It should never be used in such a concentrated form except in the open type of operation.)

5. The pleuro-bronchial fistula is one of the commonest causes of persistent cavities.

6. Subperiosteal resection of ribs at the point of division should be discarded and rib section flush with periosteum adopted.

7. Obliteration by expansion of lung which means increased vital capacity should be practiced rather than cavity diminution by collapse of the chest wall.

8. Sterilization of the cavity can often be accomplished even in long-standing cases, but re-infection will invariably occur if the parietal pleura is not removed in a case of over one year's duration, especially if it is of the haemolytic streptococcus variety.

9. Daily cultures of the wound are necessary to check the progress and to determine the amount of Dakin's solution to be used.

10. The many-step, open or fractional operation, has the following advantages:

(a) It permits direct inspection and Dakinization of the entire cavity.

(b) It permits the detection and eradication of diverticulae which are often missed on X-ray examination.

(c) It aids in the detection of osteomyelitis and foreign bodies.

(d) It insures such immediate improvement in profoundly septic cases that they will permit further operative procedure being carried out with low mortality.

(e) It affords easy removal of the parietal pleura and dissection or chemical decortication of the visceral pleura.

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- (f) It allows the detection and direct closure of bronchial fistula.
- (g) The operation can be discontinued at any stage, only to be finished later when the patient's condition permits with a mortality far below that of the standard radical operation.

As regards the treatment of this type of case, our entire procedure is based upon the recognition of the soundness of the contention learned in the school of experience, that there is no short cut nor abbreviated method whereby a cure can be obtained. Like every new departure in surgery, the operative technic is naturally the paramount prerequisite of that particular method, yet, in this instance, constant and careful Dakinization, together with massive and irksome daily dressings necessary to ensure sterilization, are indispensable desiderata in obtaining an ample reward for all the hardship the patient has endured.

In conclusion the author feels that he would have been decidedly remiss did he fail to acknowledge his indebtedness to Captain Arthur D. Haverstock and Captain C. E. Dovell, Medical Corps, U. S. Army, to whose lot fell the bulk of the routine ward treatment of these cases. Captain Haverstock was associated with him in the early part of this work and by close observation and tireless efforts did much to produce the results obtained at that time. Captain Dovell has subsequently carried on with success the major portion of the experiments, and has done all the practical work in developing the technic in regard to the use of gentian violet, both for decortication purposes and for the treatment of bronchial fistulæ. He has also made it possible to handle the intercurrent and resistant pyocyanous skin infections, through his introduction of the use of twenty per cent. silver nucleate in the treatment of such annoying conditions.

Grateful acknowledgment is hereby made to these two officers for their cordial coöperation and unremitting assistance in carrying on this work.

CASE RECORDS *

CASE I.—R. G. H., age thirty-three years, developed influenza and pneumonia September 8, 1918, complicated by empyema, left pleural cavity, hæmolytic streptococcus type, September 18, 1918. Aspirated twice.

October 22, 1918. Thoracotomy; resection of 10 cm. of seventh rib, mid-axillary line, with the institution of drainage and irrigation with Dakin's solution.

September 10, 1919. Decortication operation with resection of seventh, eighth, ninth and tenth ribs; dependent drainage.

Patient received a number of minor operations to institute drainage.

Admitted to Empyema Service, September 24, 1920.

Condition on admission: Stretcher case; poorly nourished; anæmic; very much under weight—normal weight 155 pounds; present weight, 117 pounds; fingers clubbed; extremities edematous.

Examination of chest revealed sinus discharging pus ninth interspace, mid-axillary line, left chest, with a large irregular-shaped cavity extending from second to eighth rib, mid-axillary line (Fig. 9).

*Twenty cases only are included in these records, owing to the want of space for the entire series.

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Radiographs showed marked collapse of left lung with extensive scar formation and marked thickening of parietal pleura, left lateral chest, with considerable proliferation of new bone formation from resected ribs and some osteomyelitis of rib stumps. Small secondary cavity or diverticulum extending into the hilus of lung. Capacity of cavity, 300 c.c.

Bacteriological examination: Wassermann negative; sputum negative for tubercle bacilli; white blood-cells, 13,950; red blood-cells, 3,810,000; urine negative; culture from cavity showed heavy growth of haemolytic streptococcus. Blood-pressure: systolic, 110; diastolic, 80; pulse-pressure, 30; vital capacity reading, 1500 c.c.

December 9, 1920. Operation.—Resection of 15 cm. of third, fourth, fifth and sixth ribs, postular scapular line, left chest; cavity laid wide open and preparation for active Dakinization.

February 4, 1921. Operation.—Resection of 10 cm. of seventh, eighth, ninth and tenth ribs, posterior axillary line; excision of thickened parietal pleura, forming roof of cavity; skin inverted over muscle and saved for final closure. Entire cavity exposed over posterior aspect and active Dakinization continued.

April 7, 1921. Operation.—Resection of 10 cm. of sixth, seventh and eighth ribs, anterior axillary line; left chest and the anterior aspect of cavity laid wide open for the continued Dakinization. Discussion of visceral pleura to allow lung expansion and the thickened parietal pleura excised.

May 6, 1921. Operation.—Partial plastic closure upper aspect of posterior cavity; implantation of a portion of subscapularis and infraspinatus muscle into apex of cavity; superficial muscles, which had been saved at previous operation, brought in apposition and sutured; skin closed by silkworm gut; multiple scarification of skin to cause relaxation; active Dakinization continued.

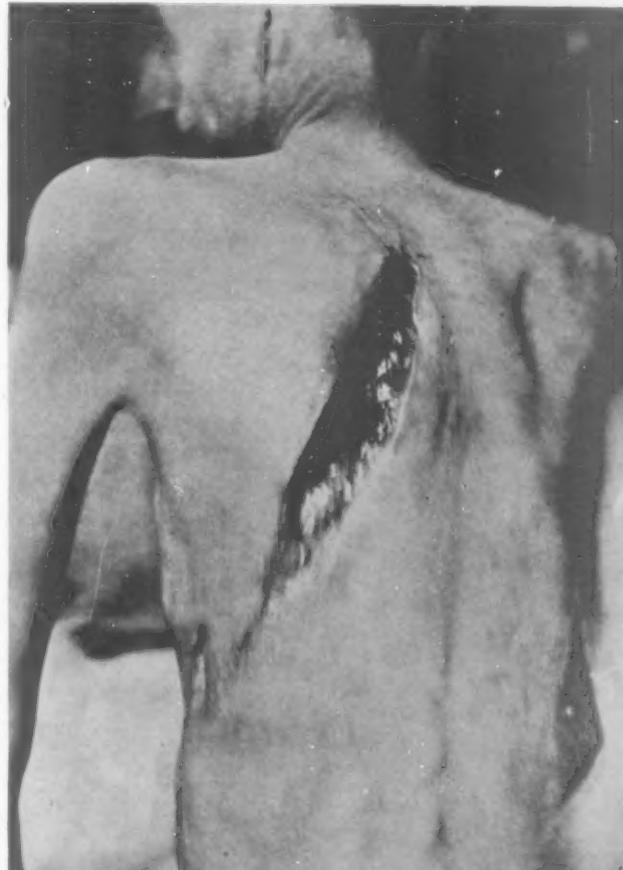


FIG. 9.—Case I. Showing great emaciation when admitted. High incision to reach extra-pleural extension of infection.

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June 21, 1921. Operation.—Partial closure; anterior aspect of cavity; superficial muscles brought in apposition and sutured; skin closed with silkworm gut. Posterior aspect of cavity left open for active Dakinization.

July 18, 1921. Operation.—Removal of segments of seventh, eighth and ninth ribs, which had previously been resected in anterior axillary line and detached posteriorly when cavity was laid wide open. Active Dakinization continued (Fig. 10).



FIG. 10.—Case I. Regenerated necrosed ribs exposed for removal.

February 24, 1922. Incision of scar in posterior scapular area; removal of necrosed rib stump which had been left extrapleural at last operation. Wound left wide open for active Dakinization and observation.

March 1, 1922. Empyema cavity completely obliterated; lung well expanded; had been healed since November 20, 1921; rib resection above has no relation to empyema.

April 15, 1922. Patient improving; exposed to sun daily; on calisthenics and lung exercises; appetite good, weight and strength returning.

June 26, 1922. Patient entirely healed; X-ray shows all cavity formation obliterated; lung well expanded; general condition excellent; weight on admission

September 8, 1921. Operation.—Resection of 5 cm. of regenerated tenth rib stumps, which had become osteomyelitic. Dakinization continued.

November 9, 1921. Secondary closure with implantation of superficial muscle body in remaining cavity formation. Additional superficial muscles brought over the implantation and fixed, leaving the resected rib stumps extrapleural when skin was brought in apposition. This was done because case was considered tubercular, due to extensive rib necrosis; should there be any additional necrosis of rib stumps, condition would be extrapleural and localized.

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117 pounds; present weight 140 pounds; vital capacity reading, 2300 c.c. (Fig. 11).

Factors to be combated in this case are:

1. Haemolytic streptococcus infection.
2. Osteomyelitis of ribs and rib stumps with bridging and overlapping.
3. Secondary cavity and diverticuli.
4. Marked regeneration with bridging and overlapping of previously resected rib, rendering an almost solid plate of bone to be removed.

CASE II.—C. G., age thirty-three years, developed influenza and pneumonia, October 21, 1918, complicated by empyema, left pleural cavity, haemolytic streptococcus type, November 16, 1918; aspirated four times.

November 22, 1918. Thoracotomy, resection of portion of seventh rib.

March 3, 1919. Additional rib resection and drainage instituted.

May 3, 1919. Operation.—Resection of 20 cm. of eighth rib, posterior axillary line, left chest; Carrel tube inserted and good drainage instituted.

Treated by this method until June 24, 1919, when he was transferred to Oteen, N. C., on a diagnosis of suspected tuberculosis.

August 7, 1919. Operation.—Resection of portions of sixth, seventh, and eighth ribs; Dakinization continued.

October 31, 1919. Estlander type of operation with resection of portions of third, fourth, fifth and sixth ribs and a portion of the regenerated seventh rib, with partial collapse of the left chest wall. Drainage instituted.

February 19, 1920. Resection of portions of second, third and fourth ribs, mid-clavicular line, thus causing additional collapse of left chest wall.

June 2, 1920. Incision made over seventh, eighth and ninth ribs and necrotic posterior stump resected.

Admitted to Empyema Service, January 17, 1921.

Condition on admission: Ambulatory case; anaemic, highly septic; poorly



FIG. 11.—Case I. Final result.

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nourished and considerably under weight. Normal weight 175 pounds; present weight 110 pounds. Fingers clubbed; extremities edematous.

Examination of chest revealed multiple sinuses in scars of previous operations, leading down to resected rib stumps, which had become osteomyelitis; marked deformity in contour of left chest due to previous collapsing operations (Fig. 12). Large cavity formation extending from first rib to tenth rib, lateral chest.

Radiograph showed marked collapse of left lung with extensive thickening of the pleura from apex to base and a bismuth-filled cavity, as noted above, with a capacity of 400 c.c. with osteomyelitis and sequestration of rib stumps.

Bacteriological examination: Wassermann negative; sputum negative for tubercle bacilli; blood count: white blood-cells, 10,300; red blood-cells, 3,640,000; urine negative; culture from cavity showed heavy growth of haemolytic streptococcus. Blood-pressure: systolic, 108; diastolic, 80; pulse-pressure, 28; vital capacity reading, 1500 c.c.

Surgical Treatment, Fractional Procedure.—January 21, 1921. Incision along posterior scapular line, with resection of necrotic rib stumps; excision of thickened parietal pleura and scar tissue; skin inverted over muscle to preserve for final closure; cavity left open for active Dakinization.

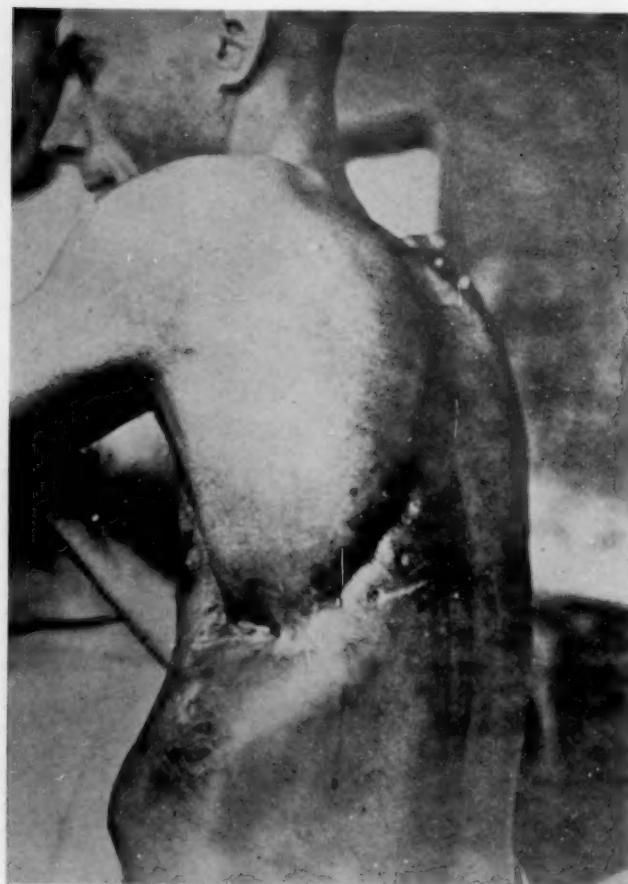


FIG. 12.—Case II. Showing condition of patient when admitted to Empyema Service, with multiple fistula and general osteomyelitis.

March 16, 1921. Resection anterior portion of eighth, ninth and tenth rib stumps, with excision of roof of cavity; removal of all thickened pleura; dissection of visceral pleura to allow lung expansion; active Dakinization continued.

April 8, 1921. Resection of fourth, fifth and sixth ribs, mid-axillary line; excision of thickened pleura; exposure of entire cavity; dakinization continued.

May 7, 1921. Resection of necrotic rib stumps; dissection of visceral pleura to allow lung expansion; Dakinization continued (Fig. 13).

June 3, 1921. Partial plastic closure of lower part of cavity converging with diaphragm; implantation of portion of superficial muscle body into same and a

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plastic skin sutured over defect; Dakinization continued in upper aspect of cavity.

July 11, 1921. Partial plastic closure of upper posterior aspect of cavity by means of implantation of a portion of the subscapularis and infraspinatus muscle, to obliterate the remaining portion which had not been obliterated by lung expansion. Skin and superficial muscles brought in apposition and sutured. Remaining portion of cavity left open for active Dakinization.

November 28, 1921. Resection of necrotic rib stumps third, fourth and fifth ribs, anterior aspect; excision of overlying thickened pleura. Removal of detached sequestered rib stump from apex of remaining cavity formation. Active Dakinization continued.

February 3, 1922. Plastic closure of remaining cavity formation by means of implantation of superficial muscle bodies which had been saved at previous operation; remaining superficial muscle structure brought in apposition and sutured. Excision of scar formation along skin margin and skin closed by silkworm gut. Multiple scarification of skin to cause relaxation. Rubber dam drainage for forty-eight hours (Fig. 14).

March 11, 1922. Cavity completely obliterated: lung well expanded.

X-ray shows no evidence of osteomyelitis of remaining rib stumps. General condition good. Patient gaining weight.

June 21, 1922. Excision of old adherent scar and plastic skin closure of area with silkworm gut; multiple scarification of skin to cause relaxation; rubber dam drainage forty-eight hours.

June 28, 1922. Skin area entirely healed; lung expanded in apposition with chest wall; general condition excellent; weight on admission 110 pounds; present weight 125 pounds; vital capacity reading, 1900 c.c. (Fig. 15).

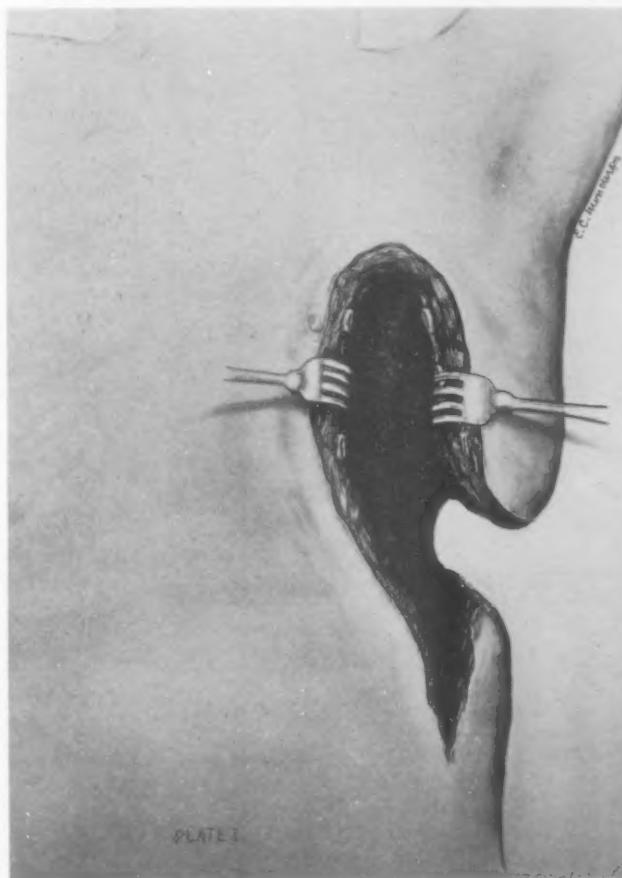


PLATE I

FIG. 13.—Case II. Showing defect after resection of necrotic ribs.

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Factors to be combated in this case are:

1. Haemolytic streptococcus infection.
 2. Osteomyelitis of rib stumps.
 3. Numerous collapsing operations left chest wall with bridging and overlapping by regenerated rib formation.
 4. Marked disturbance of metabolism due to deviation of mediastinum.
- Patient could not withstand any fractional operation without all of the measures to combat shock.

June 30, 1922. Patient will be given a thirty-day leave and will be ready for discharge from hospital on his return.

CASE V.—L. J. McC., age twenty-four years, developed pneumonia February 18, 1919, complicated by empyema, right pleural cavity, haemolytic streptococcus type, February 22, 1919.

Received eleven operations prior to admission to the Empyema Service, including thoracotomies, Schede and Estlander type of operation, with resection of third to eleventh ribs inclusive, right side, and attempted resection of second rib, right side.

Admitted to Empyema Service, November 15, 1920.

Condition on admission: Patient acutely sick from accumulation of pus in old healed cavity. Patient is about 25 pounds



FIG. 14.—Case II. Process of plastic closure by muscle implantation.

under weight. Radiograph shows a dense shadow over the right base, suggestive of fluid. There is thickened pleura from base to apex. The lung is collapsed. There has been a resection of the third to eleventh ribs inclusive, with bone proliferation and bridging.

The external right chest resembles the contour lines of a map from the many previous lines of incision. Patient has had to date twelve operations from simple thoracotomy to the extensive collapsing and mutilating type of operation.

Bacteriological examination: Wassermann negative; sputum negative for

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tubercle bacilli; blood shows slight anaemia with high leucocyte count, due to acute condition. *Streptococcus haemolyticus* has been the prevailing and dominant organism in this case from the beginning.

January 10, 1921. Patient showed evidence of re-accumulation of pus in chest. Needling with trocar canula and threading of small drainage tube into cavity permitting escape of pus. On attempting to use Dakin solution, it was found that patient had a pleurobronchial fistula and the solution had to be discontinued.

Surgical Treatment, Fractional Procedure.—January 31, 1921. Incision in line of previous incision in anterior axillary line. Portion of fifth rib resected. Cavity left open in preparation for active Dakinization.

April 11, 1921.

Exposure of cavity posteriorly and further exposure anteriorly with resection of necrotic rib stumps of sixth, seventh and eighth ribs posteriorly, and fourth, fifth and sixth ribs anteriorly. The two incisions were separate and not connected externally, but a narrow sinus led from one to the other within the cavity proper. Both wounds left widely open for Dakinization.

April 21, 1921.

Incision connecting the anterior and posterior wounds; dissection of connecting sinus tract internally with excision of intervening rib stumps. The chest now presented one large deep wound of about 500 c.c. capacity. Cavity left widely open for active Dakinization.

May 18, 1921. Small sinus tract found in upper angle of wound and excised.

June 8, 1921. Plastic closure. The bronchial fistula was still patent and had resisted closure by cauterization. At this operation, the cavity which had obliterated about 75 per cent., could be entirely obliterated by the implantation of muscle bodies lying along the upper and lower margins of the cavity. The bronchial fistula was closed by mobilizing it, inserting a purse-string and slightly inverting it, then the area was carefully covered in by a small muscle implantation sutured



FIG. 15.—Case II. Final result.

in situ (Fig. 16). The skin and subcutaneous tissues were freely undermined on both sides and the tissue united by sutures under some tension. Rubber tissue drainage. Only superficial muscle slough followed.

July 26, 1921. There was a little undermining of the skin in the middle third of the wound with slight slough due to tension. Superficial incision was made and the skin divided. Wound allowed to granulate. Following this the wound gradually healed.

August 12, 1921. Almost healed; Dakin's has been stopped and gentian violet is being used instead, as there is only a small place in the skin to close.

September 2, 1921. Patient healed; looks fine; feels strong; appetite good; gaining in weight.

October 1, 1921. Patient granted two months leave of absence.

May 11, 1922. Patient has been healed eight months; discharged cured (Fig. 17).

Factors to be combated are:

1. Streptococcus haemolyticus.
2. Massive collapse of lung with an almost total pneumothorax.
3. Numerous diverticulae and recesses which infected, and having no drainage, were the foci of frequent recurrence.

4. Sequestra following extensive involvement of many of the rib stumps.
5. At the time of the first fractional operation, the chest wall was so scarred from twelve previous operations and there was such extensive cross-bone formation and bridging that operation for the removal of these structures overlying the cavity was made extremely difficult.
6. Pleurobronchial fistula present.

CASE VI.—M. C. B., age twenty-seven years, developed pneumonia, right lower lobe, April 26, 1918, complicated by empyema, right pleural cavity, May 1, 1918. Aspirated May 2, 1918, and 500 c.c. of fluid removed. Aspirated every other day and fluid removed on ten occasions.

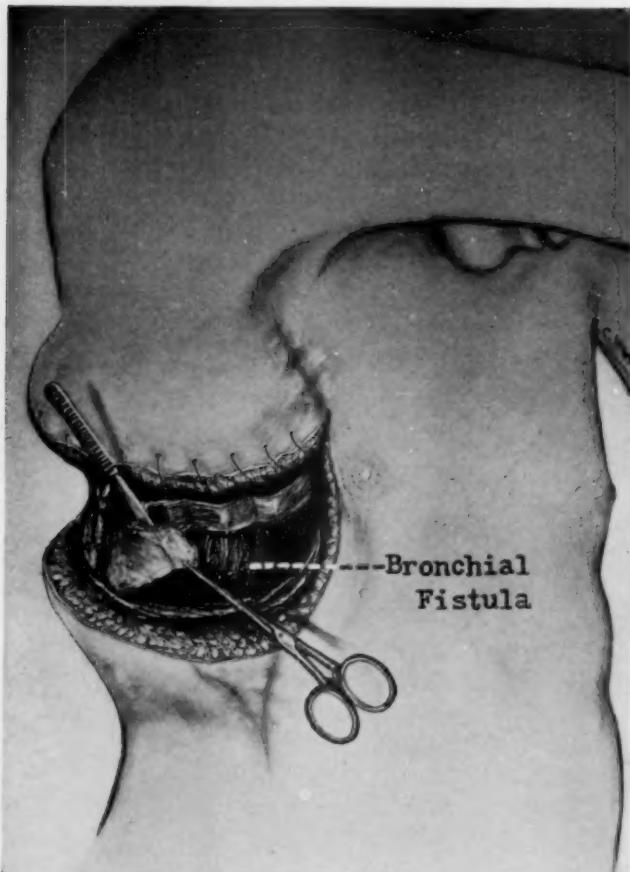


FIG. 16.—Case V. Showing bronchial fistula and process of plastic closure by muscle implantation.

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May 28, 1918. Intercostal thoracotomy. Wound drained for five months following this. Patient had intermittent Dakinization.

August 15, 1918. Bismuth paste injected into cavity and wound allowed to close. Capacity of cavity at this time about 500 c.c. Wound remained closed until November, when the sinus reopened and drained for a period of three weeks. Sinus again allowed to close and remained closed until March, 1919, when it was again reopened and continued to drain pus until the latter part of May, 1919. Cavity remained healed until June, 1920.

June 11, 1920.
Operation at a civilian hospital and part of the sixth rib resected. From this time on until he was admitted to Empyema Service, Walter Reed General Hospital, he continued to drain pus quite freely.

Admitted to Empyema Service, January 10, 1921.

Condition on admission: Normal weight 150 pounds; present weight 132 pounds. Patient anaemic and undernourished. Highly septic. Examination of chest revealed sinus at the level of the ninth interspace in the posterior axillary line, discharging pus freely. Sinus extends upward and backward and is apparently 20 cm. long.

Radiograph of chest shows resection of the sixth, seventh and eighth ribs and a partial collapse of the right lung. There is thickening of the pleura from the base to the apex. There is definite osteomyelitis with probable sequestration of the sixth rib. The sinus passes upward and backward from the level of the eighth rib and terminates in an elongated cavity which reaches the fifth interspace posteriorly. Measurements of the capacity of the cavity show that it holds about 400 c.c.

Bacteriological examination: Red blood-cells, 4,400,000; white blood-cells, 12,850; haemoglobin, 75 per cent. Wassermann negative; urine negative; blood culture negative; sputum negative for tubercle bacilli; culture from exudate of

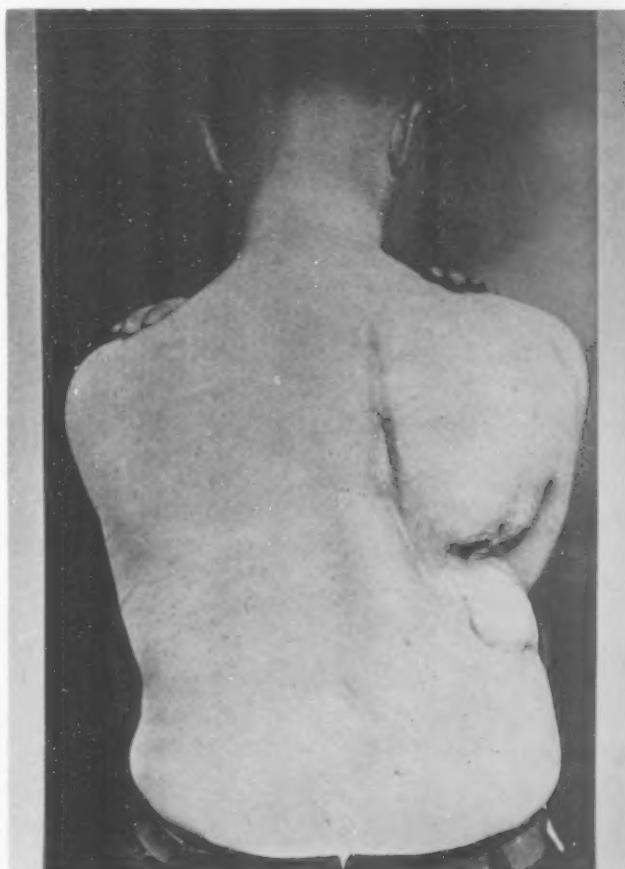


FIG. 17.—Case V. Final result

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the cavity shows *staphylococcus aureus* and also *streptococcus haemolyticus*. Patient was placed on active Dakinization for three days previous to operation.

January 13, 1921. Partial resection of eighth and ninth ribs for drainage purposes only, with removal of the outer and lower wall of the cavity.

Following this operation, patient was treated intensively with Dakin's solution until February 15, 1921, when the second step of the operative procedure was done. At this time there was resection of the fifth, sixth and seventh ribs posterior, with an excision of all tissues forming the roof of the cavity. Cavity was

left widely open and actively Dakinized.

April 8, 1921. The third step was undertaken. Sections of third, fourth, fifth and sixth ribs were removed; sterile cultures of the wound having been obtained, prior to operation, it was thought advisable to attempt to obliterate the upper angle of the cavity by muscle implantation. A part of the erector spinae muscle was split and implanted into the apex of the wound and sutured in place. Practically all of the muscle thus implanted was retained and there was but little sloughing. The lower part of the wound seemed to be obliterating rap-

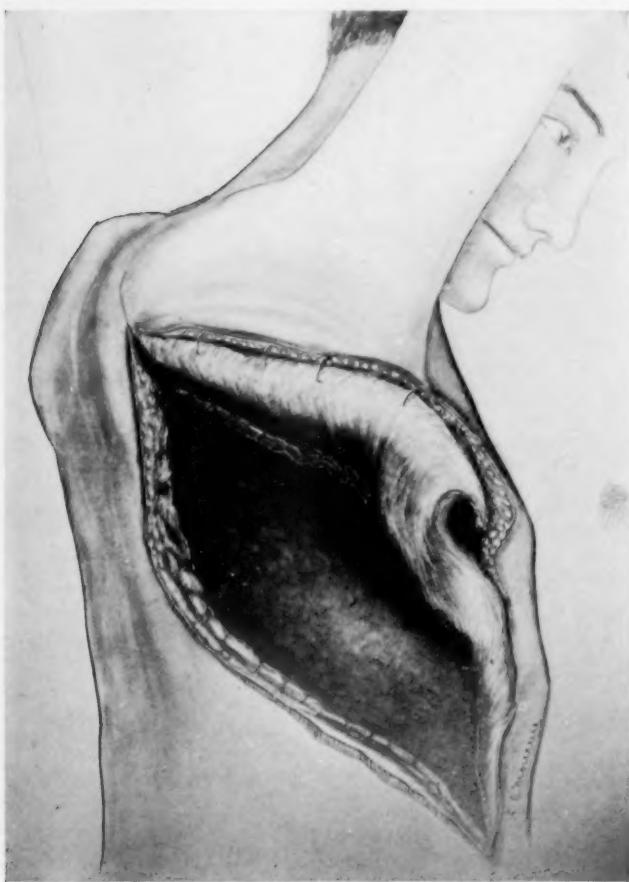


FIG. 18.—Case VI. Showing closure of upper portion of cavity by muscular transplant.

idly and the patient's general condition had been improved considerably (Fig. 18).

May 2, 1921. X-ray showed an osteomyelitis with sequestration of the terminal end of the previously resected third rib. The muscle body, which had been implanted filling in this area, was split and the sequestration removed.

July 7, 1921. Operation.—A small fistulous tract found leading down to the ninth rib stump. This portion of the rib resected and a plastic closure of the lower half of the wound by implantation of the contiguous muscle bodies was done. The skin was undermined on either side and brought forward, covering in all of the lower half of the wound (Fig. 19).

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FIG. 19.—Case VI. Implantation of contiguous muscle bodies.



FIG. 20.—Case VI. Final Result.

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July 27, 1921. Operation.—Plastic closure of the upper half of the wound by implantation of subscapularis muscle and sliding skin flap from either side brought forward and sutured. Rubber tissue drainage placed in the line of closure and a firm dressing applied to the wound.

October, 1921. Patient entirely healed and feeling fine. At the time of the first plastic operation, the capacity of the cavity had diminished to about one-fourth of its original size. On discharge the X-ray showed moderate collapse of the right chest wall; a rather marked thickening of the pleura but no cavitation and

with the lung well expanded.

Patient discharged cured January 5, 1922. Healed three months (Fig. 20).

Factors to be combated in this case are:

1. Hæmolytic streptococcus organism present.

2. Osteomyelitis with rib sequestration.

3. Beck's bismuth paste which had remained in cavity thirteen months.

4. Three diverticula draining into main cavity.

CASE VIII.—S. R., aged twenty-eight years, developed pneumonia March 30, 1918, complicated by empyema, right pleural cavity, hæmolytic streptococcus type, April 3, 1918. Aspirated.

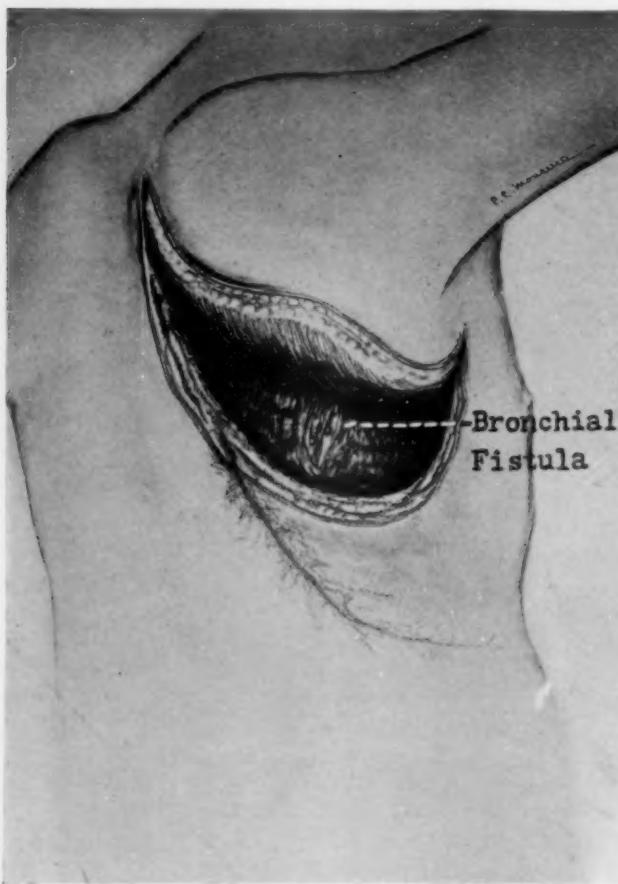


FIG. 21.—Case VIII. Showing extent of incision and position of bronchial fistula.

April 3, 1918. Intercostal thoracotomy seventh interspace, mid-axillary line, and drainage instituted; daily irrigation with Dakin's solution and dichloramine.

June 10, 1918. Another cavity found draining into the one that was opened; capacity of same now 450 c.c.; Dakin tubes inserted and classical Carrel-Dakin technic for the sterilization of wounds instituted through primary incision. Daily aspiration of other areas of chest, and cavity would close and cavity would again fill with pus and drainage would be re-instituted by opening up the original wound. Formalin and glycerin 2 per cent. were used, but no improvement noted. Treated by this method of procedure for some time and when wound would close, negative pressure treatment was tried.

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January 14, 1919. Operation.—Resection of a portion of the ninth rib posterior axillary line right chest; dependent drainage instituted and active Dakinization started.

August 19, 1919. Decortication operation with fish-hook incision and resection of fourth, fifth, sixth, seventh, eighth, ninth, tenth and eleventh ribs; outer wall of cavity removed en masse; visceral pleura decorticated. Muscle and skin closure with one drainage tube in dependent portion of wound.

September 23, 1919. Wound healed. January 10, 1920. Wound re-opened cavity present.

Bronchial fistula noted and haemoptysis with persistent cough; almost impossible to irrigate the cavity with any solution due to the fistula.

August 19, 1919. Diagnosed as chronic parenchymatous nephritis in conjunction with empyema; cavity kept open and irrigated in spite of patent fistula. Haemoptysis persisted; dressed and treated in the manner stated until November 1, 1920.

Admitted to Empyema Service, November 20, 1920.

Condition on admission: Ambulatory case, anaemic, highly septic, poorly nourished and considerably under weight. Normal weight 147 pounds; present weight 117 pounds. Persistent cough with frequent expectoration of purulent blood-tinged sputum.

Examination of chest revealed marked deformity in the contour of the right chest wall due to collapsing operation. A sinus discharging pus, posterior scapular line, at a level corresponding to eighth rib, was present.

Radiographs showed marked collapse of right lung with extensive thickening of pleura, right chest, from apex to base, and a long cavity formation extending from second to ninth rib, lateral chest, with a capacity of 300 c.c. A large pleuro-

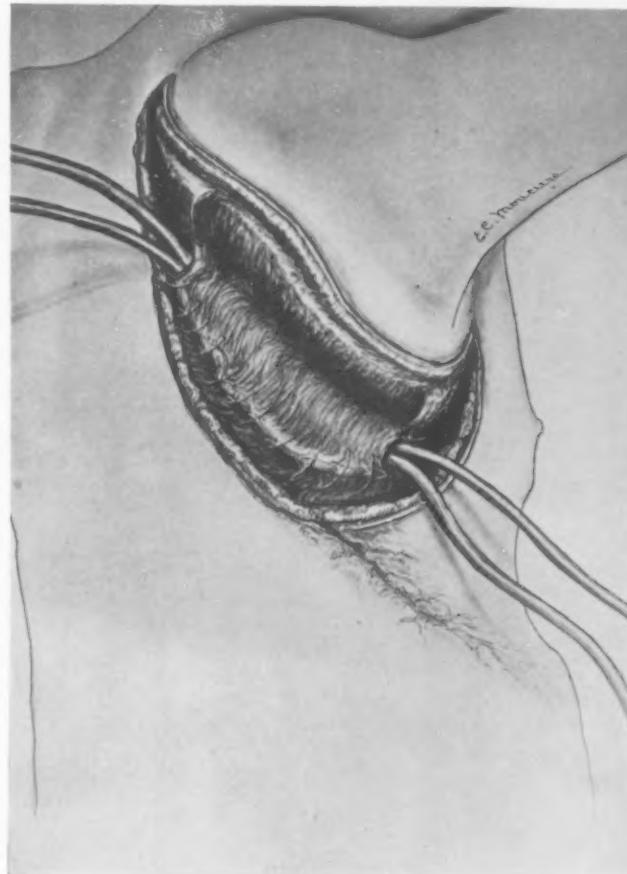


FIG. 22.—Case VIII. Implantation of levator anguli scapuli and erector spinae muscles over bronchial fistula.

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bronchial fistula present and some regeneration and overlapping of rib stumps with osteomyelitic changes.

Bacteriological examination: Wassermann negative; sputum negative for tubercle bacilli; white blood-cells, 12,300; red blood-cells, 3,480,000; urine showed heavy trace of albumin; culture from cavity showed heavy growth of haemolytic streptococcus; blood-pressure: systolic, 148; diastolic, 90; pulse-pressure, 58; vital capacity reading, 1500 c.c.

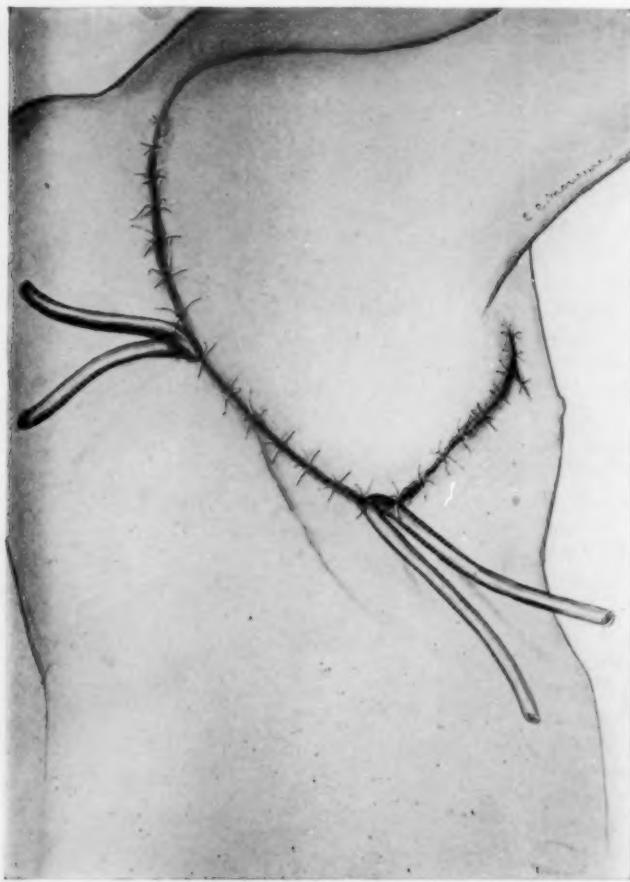


FIG. 23.—Case VIII. Secondary closure.

Surgical Treatment, Fractional Procedure.—November 29, 1920. Operation. Incision along old posterior scar line and extended by a "U"-like figure to anterior axillary line; entire cavity laid wide open; excision of all thickened pleura forming roof of cavity; skin and remaining muscle tissue saved for final closure. Fistula noted and mobilization of lung about same preparation of cavity for active dakinization.

January 20, 1921. Operation.—Resection of 10 cm. of second, third, fourth and fifth ribs, posterior scapular line, right chest; implantation of a portion of the

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levator anguli scapulii and erector spinae muscles into apex of cavity over pleuro-bronchial fistula, and closure of upper aspect of cavity, muscle and skin. Cavity about sterile, but active Dakinization continued in lower aspect, which was left open (Fig. 22).

June 1, 1921. Secondary closure of remaining wound; severed superficial muscles and skin brought in apposition and sutured; rubber tube and rubber dam



FIG. 24.—Case VIII. Final results.

drainage for forty-eight hours; multiple scarifications of skin to cause relaxation (Fig. 23).

July 12, 1921. Operation.—Fistula still patent; small incision over posterior aspect in old scar line. Lung mobilized about fistula. Tract ligated by means of purse-string and another muscle flap implanted over area of closed fistula. Wound packed and allowed to granulate.

August 4, 1921. Fistula still patent. Treated with two per cent. alcoholic solution of gentian violet and the next day the communication was closed and remained closed. Wound granulated and entirely healed on August 22, 1921.

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September 30, 1921. Patient shows all cavity formation obliterated; lung well expanded and fistula remaining closed; is gaining weight; general condition excellent.

October 10, 1921. Patient cured; weight on admission 117 pounds; present weight 140 pounds. General condition excellent; vital capacity, 2300 c.c.

Factors to be combated in this case are:

1. Haemolytic streptococcus present.
2. Osteomyelitis.
3. Nephritis.
4. Pleurobronchial fistula.
5. Marked destruction in soft tissues and deformity of chest wall.

Patient discharged cured, January 7, 1922, healed four months.

(TO BE CONTINUED)

PULMONARY FAT EMBOLISM *

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PULMONARY fat embolism has been most often noted in cases of fractured bones.¹ It has long been known that free liquid fat is present in the blood following injury to fatty tissue, and emboli in other organs have been observed. Just why the bulk of fat, when placed into the blood-stream, should lodge in the lungs is a matter of speculation. Gauss has shown that by the simple addition of oil to blood the viscosity is greatly increased, thereby slowing the stream as it passes through the lung capillaries which are long and poorly supported.

It has been shown that pulmonary fat embolism is at least a potential factor in the cause of death following any surgical operation in which fatty tissue has been injured. The condition may occur following any type of operations in the abdomen through the abdominal wall, following removal of the mammary glands, both radical and simple herniotomy, inguinal and ventral, removal of fatty tumors, thyroideectomy, and injury to bony tissue, especially by fracture. Warthin also found it following burns.

Etiology.—Man normally has from 0.5 to 0.85 per cent. of fat in the blood. The amount may be increased somewhat by ingestion. In certain diseases, such as diabetes mellitus, nephritis, tuberculosis, malaria, and cholera and also following poisoning by phosphorus and carbon monoxide, the fat content of the blood is increased. In order to permit the entrance of fat into the circulation in amounts even to approach the amount of free fat in the blood-stream in pulmonary fat embolism, there must first be injury to the fatty tissue, and second a break in the continuity of the blood-stream. Entrance of fat into the circulation by way of the lymphatics is lightly regarded.¹ If the vascular system is injured sufficiently to take up fat, there are several factors which make it easy literally to fill the blood-stream with

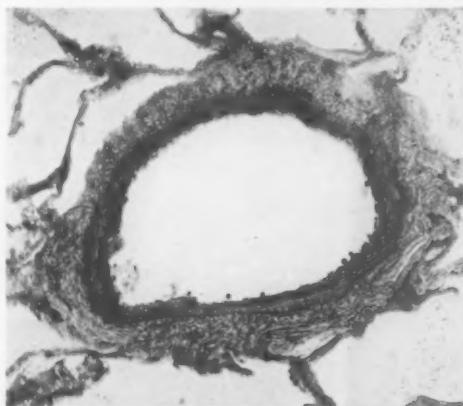


FIG. 1.—(Case A176353). Section through a large vessel showing small fat droplets. From the size of the vessel this is probably the amount of fat that is free in the blood-stream. (x 50.)

* Abridgment of thesis submitted to the Faculty of the Graduate School of the University of Minnesota, in partial fulfillment of the requirements for the degree of Master of Science in Surgery, June, 1921.

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free liquid fat. Partial haemostasis is particularly important. Other factors are mobility of the injured parts, weakened circulation, incomplete or shallow breathing, and inhalation of lipoidal solvents. Bissell believes that certain fats, from the gross appearance, are probably more readily taken up by the blood than others.

That incomplete haemostasis is an important factor is shown by the fatal cases in which operations have been performed on the abdominal wall. Almost without exception haematomas filled with fat droplets have been found at necropsy. The same may be said of operations on the breast which have had a fatal outcome from pulmonary fat embolism.

I believe that mobility of the injured tissue is probably the most important factor in the etiology, if there is injury to the fatty tissue and a break

in the venous or capillary circulation. In the abdominal wall and in the chest wall mobility depends on the rate of respiration. There are generally at least eighteen complete excursions each minute, and these may be increased to forty or more. If excavation is performed, and it usually is, this, by a vacuum effect, causes free fat to be forced into the opened blood-stream. Then, negatively speaking, in the Kondoleon operation in which a large amount of fatty tissue is destroyed no deaths from pulmonary fat embolism have been reported.

FIG. 2.—(Case A179570). Exudate from a bronchus containing fat. (x 50.)

limb, following operation in these cases, is firmly bandaged and kept at rest for at least a week. It was a common observation during the war that many of the wounded, especially those with fractures, who were transported great distances before proper surgical measures could be taken, suffered from pulmonary fat embolism. I noticed this complication particularly in one location. In the exigency of war two armies were placed side by side. The ambulance corps was just behind, drawing wounded from each. One army had ample splints to use, the other had none. Almost without exception the patients with non-splinted fractures of large bones were found in very poor condition. The ordinary resuscitation methods aided these patients but little, and even in cases with poorly-splinted fractures the mortality was high. I performed necropsies in eight fatal fracture cases and found an astonishing amount of fat in the lungs in all.

The entrance of fat into the previously weakened circulation tends further to weaken it. When fat enters the venous circulation the venous pressure is increased and the arterial pressure decreased, consequently the blood flows at a slower rate. As has been shown by various writers^{1, 12} when free liquid

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fat enters the venous circulation, most of it collects in the pulmonary capillaries. If there is incomplete aeration of the lung by shallow respiration, the free liquid fat tends to remain there and more collects as it enters the pulmonary circulation.

Symptoms.—There are two types of symptoms, pulmonary and cerebral. They may appear singly or in combination. In the pulmonary type the respiratory rate is increased and shallow; dyspnea soon develops, followed by cough and cyanosis; expectoration may be present and there may be blood in the sputum. The pulse-rate is increased, and the pressure is low. The radial pulse is very small in a great many cases. These symptoms may come on exceedingly fast. In one case reported by Bissell the respiratory symptoms began to appear during operation. The amount of liquid fat liberated into the blood-stream seems to determine the suddenness of symptoms. There is a type of case in which the symptoms are dormant or absent for a time; later the respiratory symptoms appear. These may appear, then partly or wholly disappear, and reappear again in from five to twelve days with fatal result.¹ This is explained as being due to fat passing through the pulmonary circulation into the general circulation and again collecting in the pulmonary capillaries.

The temperature is of two types: In a case confounded with shock the temperature is normal or subnormal, and the skin and mucous membrane are blanched or ashen. In the majority of cases the temperature is elevated; in fact, it is quite the exception to have a normal or subnormal temperature. In only two of the fatal cases in the Mayo Clinic since 1916 has the temperature been normal. Often there is a sudden elevation of temperature before death. If there is bloody expectoration it is explained by the rupture of some of the capillaries of the lung. This produces hemorrhages into the bronchial tree, which are similar to the patches on the surface of the lung in the form of small petechial hemorrhages.

When the fat passes through the pulmonary system and out into the general circulation the central nervous system may receive an overwhelming amount in the form of emboli. A chain of cerebral symptoms follow, ushered in by restlessness, headache, uneasiness, mental dullness, stupor, and delirium. The delirium may vary from a mild type to a very disturbed state accompanied by hallucination. The reflexes are dulled and tremor, convulsions, and

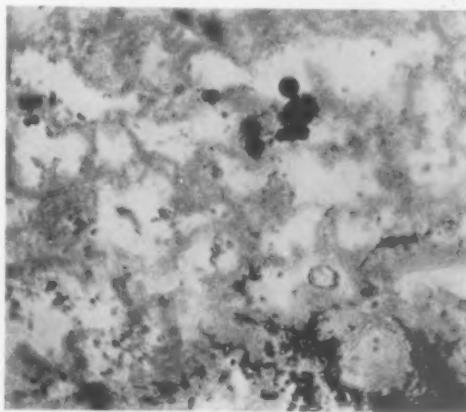


FIG. 3.—(Case A181050). Showers of small fat droplets filling the capillaries of the lung. The larger vessels are quite filled with fat. (x 50.)

paralysis have been reported. When the cerebral symptoms are predominant the diagnosis is often confounded with delirium tremens. The cerebral symptoms usually appear following the pulmonary symptoms, as a rule, from two to eight days following injury.^{1, 4, 7}

Helpful aids to the diagnosis of fat embolism are the discovery of pulmonary oedema, invariably found on examination of the chest, signs of bronchopneumonia at the bases, with the right ventricle dilated, small petechial hemorrhages in the skin over the chest, and blood-stained sputum containing numerous fat droplets. Fat droplets appearing early in the sputum is one of the newer signs of pulmonary fat embolism and should not be overlooked. Warthin found them the second day after injury. At necropsy the droplets may be found in the mucous exudate of the trachea and large bronchi. Associated

with the fat droplets in the sputum there may be alveolar cells and phagocytes containing fat droplets. Globules of fat may be present in the urine. They are easily detected on the surface if the urine is held up to the light. The lipuria may appear at once; it usually appears at some time during the complication, but death from fat embolism may occur without lipuria. This is explained by retention by the lung tissue of sufficient fat to cause death without free fat being forced into the general circulation. Besides lipuria, there may be casts; certain observers

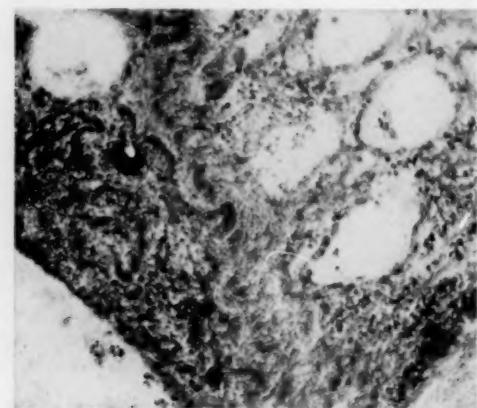


FIG. 4.—(Case A185831). Showers of fat droplets in capillaries and larger vessels of lung and numerous fat droplets in alveoli. (x 50.)

report the presence of brownish casts.⁹ In some instances free fat may be obtained from the general circulation by vena puncture.¹² By examination of the eye grounds fat may be seen circulating in the retinal vessels.³

In explaining the difference between pulmonary fat embolism and shock many observers assert that there is a quiescent period in pulmonary fat embolism before symptoms appear.⁵ This is true in some instances, but in others the symptoms and signs may appear during operation or immediately following injury.

Pathology.—Lipæmia, with a subsequent distribution to the tissues, principally the lung, of emboli of liquid fat, is the first pathologic change observed. This takes on the rôle of infarction in the tissues of the body when it leaves the lungs. These infarctions go through the same pathologic change as that of an infarct in the same tissue caused by any foreign material. A wound in the fatty tissue, filled or partly filled with a blood clot and loaded with free fat droplets, would seem to be an ideal way of feeding the venous

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system with fat. If the area is rich in fat, more fat can be distributed to the blood.

The capillaries of the lungs are filled with fat droplets. Fat may be present in the small veins of the tissue of the lung and free fat droplets may be seen in the trachea, large bronchi and, in some instances, in the smaller bronchi. Often the capillaries of the lungs are ruptured, allowing the escape of the fatty foreign material with localized small areas of hemorrhage. This is particularly noticeable on the surface of the lung where small petechial hemorrhages are seen, which may be red or rusty brown in color, depending on the age of the hemorrhage. The lung shows considerable engorgement of blood. C \ddot{e} dema, localized or quite general, is present and usually broncho-pneumonia in the lower lobes. When the lung tissue is cut, fat droplets are seen on the blood that runs from the cut surface. The liver, spleen, heart and adrenals show fatty infarction with fatty degeneration of the tissue involved.¹² Grossly the kidneys show congestion; staining shows fat emboli in the capillaries. This is partially true of the capillaries of the glomeruli where showers of fat are to be seen. Accompanying the fat in the capillaries of the glomeruli there may be areas of hemorrhage.

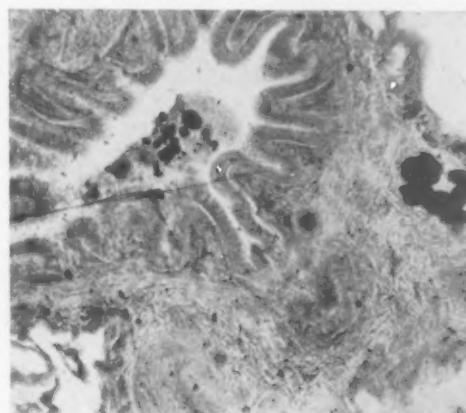


FIG. 5.—(Case A191362). Large vessels and capillaries contain fat. Fat droplets are also in the exudate of the bronchus. (x 50.)

Involvement of the Nervous System.—It is the consensus of opinion that the involvement of the nervous system is a later phase of pulmonary fat embolism.¹ There is no particular part of the central nervous system where fat emboli have not been found. Fat is present in the retinal vessels, in the capillaries of the gray and white matter, and in the capillaries of the cord. It is often seen in the perivascular spaces of the vessels in the central nervous system. C \ddot{e} dema of the nervous tissue adjacent to the emboli often occurs.

Wilms believes that a considerable quantity of fat in the blood-stream, which subsequently lodges in the lungs and other organs, comes by way of the lymphatics. On this theory he inaugurated treatment by drainage of the thoracic duct in cases of pulmonary fat embolism. The lymphatic system plays a part in the transportation of fat in fat embolism, but it is not the principal channel of transportation. The lymph-nodes adjacent to a wound causing pulmonary fat embolism may not show fat. Experimentally the lymphatics of a leg have been removed as completely as possible, and, after injury to the leg, pulmonary fat embolism occurred.

Treatment.—If bones are broken or crushed, the member should be kept

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quiet.² If transportation is demanded, the fractured member, if it is an extremity, should be put on an extension splint. The use of an Esmarch bandage or a Momberg's belt has been recommended for one-half hour following fractures around the pelvis.² Lipoidal solvents in wounds should be avoided. Complete haemostasis is important, and, in cases in which considerable fatty tissue has been injured, the wound should be drained at its dependent point.

Active treatment has not met with much success. Normal saline injected into the veins has been recommended.⁸ Schanz reports good results in the treatment of eight cases by this method. He injects the solution early into several veins, preferably a large vein. A two per cent. solution of sodium carbonate has been recommended by Czerny; Minich believes this to be useless. Experimentally it does relieve the dyspnoea. Wilms recommends drainage of the thoracic duct and reports success by this treatment in one case.

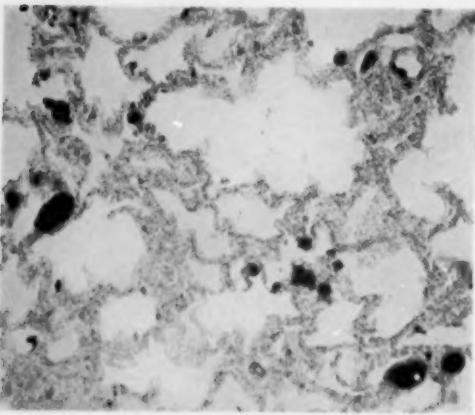


FIG. 6.—(Case A192661). Capillaries and larger vessels filled with fat. (x 50.)

given either in an attempt to dilute the blood or to "fix" the oil, as in the use of sodium carbonate, it would be better to precede such treatment with venesection. Stimulation and supportive treatment should be undertaken. Cardiac stimulants and heat should be applied to keep the blood flowing at as high a rate as can be maintained.

DISCUSSION

One outstanding point in the analysis of these cases is that an obese person undergoing a major operation, particularly if it is necessary to destroy fatty tissue, undergoes an added risk. In the greater number of cases the symptoms appear suddenly; they may develop even during the operation. A point of differentiation that has been made between shock and pulmonary fat embolism is that the symptoms of pulmonary fat embolism make their appearance later. This, as shown by the Mayo Clinic series, is not necessarily true.

Death from pulmonary fat embolism is relatively rapid. Most of the patients in the series died on the first, second, or third day after operation. Only one patient lived eleven days; one lived six days.

NOTE: The thesis as submitted contained detailed illustrated reports of sixteen cases including temperature charts. The cases are summarized in the accompanying table.

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TABLE I
Analysis of Cases in which Death Occurred from Pulmonary Fat Embolism*

Case	Operation of injury	Age, years	Weight, pounds	Height		Temperature, degrees	Pulse	Onset of symptoms	Time until death	Clinical diagnosis	Distribution of fat (at necropsy)
				Feet	Inches						
A176353	Multiple fractures . . .	75									
A176352	Multiple fractures . . .	44									
A179570	Multiple fractures . . .	28									
A181050	Partial thyroid- ectomy	42	278	6	1	99-101.5	80-100	At once	1 day	Shock	Lungs, right side of heart, and inferior vena cava
A186135	Laminectomy	31	142	5	6	103.8	135	1 day	2 days	Meningitis	Lungs, pulmonary artery, and inferior vena cava
A185831	Inguinal hernia	175	5	3	103.5	100-140	At once	1 day	1 day	Intestinal ob- struction	Lungs and inferior vena cava
A191362	Ventral hernia	67	160	5	8	100-102	80-120	2 days	11 days	Pneumonia	Lungs
A192661	Umbilical hernia	53	225	5	3	100-101	100-130	2 days	6 days	Pulmonary embolism	Lungs, inferior vena cava, and aorta
A193911	Cholecystectomy										
A212639	Fracture	9									
A202195	Total abdominal hysterectomy	50	147	5	3	102	120	At once	8 hours	Shock	Lungs
A202891	Total abdominal hysterectomy	52	200	5	7	103.8	100	At once	20 hours	Shock	Lungs, mucus of trachea, and bronchi
A108053	Ventral hernia										
A268997	Tumor of the thigh . . .	59									
A265230	Cholecystectomy	59	160								
A168252	Post-operative ven- tral hernia	60	229								

* These cases date from the year 1916, and do not include the three cases reported by Bissell in 1917.

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A positive diagnosis was made in four cases. In one (Case A202195) the surgeon inserted a glass tube with gauze into the wound, hoping to prevent the absorption of fat. The patient died in twenty hours of pulmonary fat embolism.

The temperature was elevated in all cases.

All of the cases in the series, and the three reported by Bissell, were proved by necropsy. Necropsy was not permitted in two other cases in which all the clinical symptoms pointed to pulmonary fat embolism.

Stimulative treatment, and normal saline intravenously, seemed to have little effect.

Pulmonary fat embolism should be taken into consideration as a complication in any surgical case in which there is a destruction of fatty tissue and in which there are symptoms of cyanosis, rapid or labored respiration with or without cough, elevated temperature, and an increased pulse with a low tension. The sputum, urine, and the eye grounds should be investigated for fat.

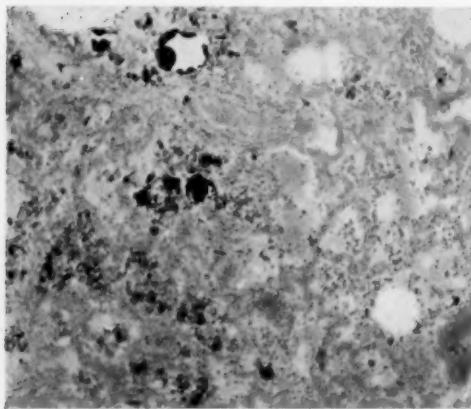


FIG. 7.—(Case A212639). Showers of small fat droplets in the lung capillaries and mucous exudate of alveoli. The large sized vessels are filled with fat. ($\times 50$)

ILLUSTRATIVE CASES

The following illustrations are presented in order to show that post-operative lipæmia and pulmonary fat embolism are frequently post-operative complications, and that they are not caused by a mass of fat in the heart or its adjacent large blood-vessels, as is generally believed.

CASE I (A176353).—A man, aged seventy-five years, was brought to the hospital in *extremis* after being transported thirty-five miles by rail from the scene of a railroad accident. Death occurred two hours later.

Necropsy revealed, besides multiple fractures of the bones of the body, a large amount of liquid fat in the inferior vena cava, the right auricle and ventricle, the pulmonary artery, and the lung parenchyma (Fig. 1).

CASE II (A179570).—A man, aged twenty-eight years, was operated on for compound fracture of both femurs and the left humerus. Death occurred on the third day.

Necropsy revealed fat droplets running from the cut surface of the lung and in the blood of the inferior vena cava (Fig. 2).

CASE III (A181050).—A man, aged forty-two years and weighing 278 pounds, had multiple adenomas of the thyroid. Thyroidectomy was performed. Convalescence was uneventful until the third day when the patient became mentally disturbed and later delirious. Death occurred on the sixth day.

Necropsy revealed a few petechial hemorrhages over the visceral pleura and an unusual amount of blood containing free fat droplets in the lung parenchyma (Fig. 3).

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CASE IV (A185831).—A man, aged thirty-one years and weighing 175 pounds, was operated on for left inguinal hernia. Seventeen days later symptoms of obstruction made a second operation necessary, at which a piece of scarred omentum causing obstruction was removed. Death occurred twenty-four hours later.

Necropsy revealed patches of semiconsolidation in the lower lobe of the right lung, intermingled with œdema and large amounts of free fat in large and small globules in the blood of the cut surface of the lung (Fig. 4).

CASE V (A191362).—A man, aged sixty-seven years, weighing 160 pounds, was operated on for post-operative ventral hernia. The hernia was repaired by a plastic operation and a spermatocele was removed. The symptoms began to appear on the second day with slightly increased temperature and pulse. Moderate cough and a slight amount of bloody sputum were accompanying symptoms on the fourth day. The sputum was negative for tuberculosis bacilli. Death occurred on the eleventh day.

Necropsy revealed pulmonary fat embolism, petechial hemorrhages over the visceral pleura, œdema of the lungs, obliterative fibrous pericarditis, and a large haematoma in the operative wound (Fig. 5).

CASE VI (A192661).—A woman, aged fifty-two years, weighing 225 pounds, was operated on for incarcerated umbilical hernia, at which the adherent omentum was separated and a segment of omentum removed. Two days after operation the temperature rose; the pulse remained between 120 and 130 for five days, then increased to 140 on the sixth day, when death occurred.

Necropsy revealed fat droplets in the blood of the aorta and the inferior vena cava. The lungs were hyperæmic and fat droplets were present in the blood from the cut surface (Fig. 6).

CASE VII (A212639).—A boy, aged nine years, was operated on for fracture of the lower end of the right femur with sequestrum. The end of the femur protruded through the scar of the former operation and was necrotic. The granulation tissue was curetted, the skin edges removed for 0.6 cm. around the old infected scar, the ends of the bone were freshened and the epiphysis replaced and held by two nails. The wound was left open. Death occurred eight hours later.

Necropsy revealed large globules of fat in the vessels of the lungs and smaller ones throughout the parenchyma (Fig. 7).

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SURGICAL TREATMENT OF HEPATIC ABSCESS AND HYDATID CYSTS EVACUATING VIA BRONCHUS

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CASE I.—For some weeks before admission to hospital a young man, aged twenty-eight, had been suffering from what his doctor had diagnosed as "an hydatid cyst which was emptying itself through his lung." It commenced with an irritable cough which had existed for about one month before he suddenly brought up a large quantity of "pus;"—immediately following this he, for the first time, suffered from fever at night, some shivering, much sweating, constant cough, with a large output of "bile."

When admitted he was emaciated, with a parched tongue, temperature 103°, pulse 120, incessant cough and spitting up purulent offensive bilious matter. I kept him under observation for a few days, but, owing to the perceptible daily increase of septicaemia with loss of strength, I felt it a duty, in scorn of consequence, to give him a chance.

Ether by open method was administered; patient was held supine slightly over the edge of operating table. I endeavored to locate cyst with a long exploring needle (eight punctures) but failed. This was rather disconcerting, and was not alleviated by the anaesthetist, who already had commenced uttering ominous words. However, concluding that the cyst had collapsed and was situated in the upper zone of liver, I adopted a plan which I had devised on a former occasion and found efficacious. Some three inches of the seventh and eighth ribs were excised in the right axillary line, the edges of the pleura were rapidly sewn to the diaphragm, the latter was then divided, and I worked my right index finger up along the superior border of the liver until I came to a dense adhesion between it and the diaphragm. The site of this adhesion was much more forward and internal than I had anticipated, and as, at the moment, the condition of the patient was alarming, I regretted that I had not had the good luck to attack through an anterior thoracotomy.

My assistants, by steady forcible retraction of ribs, afforded me the opportunity to insert the needle into liver substance just beneath the adhesion, and thanks to fortunate harmonious action of needle, knife, index finger and blunt hooks, a large drainage tube was fixed into a small collapsed fetid cavity after I had removed a small gangrenous cyst.

Iodoform gauze was packed around the tube, and as shock was marked, the patient was rapidly returned to his bed, and champagne siphoned into rectum; afterwards enemas of warm saline and brandy, strychnine and pituitary extract were administered freely, plus heat. He recovered after a prolonged convalescence, youth won. The operation was completed in seven minutes—in this instance it seemed as many hours.

CASE II.—T. S. B., aged forty-six, an engineer, was admitted to hospital January 25, 1922. Family history normal. In 1918 he served as a soldier in Northern Nigeria; three months after arrival there he had an attack of "malaria" for which he was detained three weeks in hospital. During the following two months, he had two more attacks of same, and one of dysentery, he was then invalided to England where he remained for nine months during which he put on flesh, felt very fit, without any recurrence of "Lagos troubles."

In September, 1919, he returned to the Argentine; two and a half months

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after arrival he had a severe attack of what was diagnosed as "malaria," commencing with a rigor, nausea, temperature 104° and sweating—the nocturnal fever, sweating and nausea, lasted for six weeks. At times he felt a dull pain in region below right nipple, without any cough or other sign of lung trouble.

At intervals of "three to four months" he had five similar attacks during the ensuing two years—the fever, sweating, etc., "each lasting for at least four weeks." "He never seemed to pick up in the intervals," and he experienced occasional discomfort in an area "about a hands' breadth below level of right nipple."

Four months previous to admission he felt a sudden lancinating pain in left groin, the limb "immediately became swollen and painful." Diagnosis by his doctor was acute femoral phlebitis, two days later the same occurred on the other side, both legs continued swollen and painful, and he was confined to bed for eleven weeks. Within a few weeks the veins all over abdomen became gradually enlarged. "Thrombosis of both Common Iliac Veins or Inferior Vena Cava."

While still in bed—on December 24, 1921—he was suddenly seized with an acute stabbing pain in right chest with violent spasms of coughing. "After about an hour of this he coughed up a cupful of stuff like gum and about ten minutes later brought up over a cupful and a half of bloody sticky matter." Diagnosis—"Broncho-pneumonia." During the following thirty days he became extremely emaciated, with foul tongue, nocturnal fever, profuse sweating, distressing cough, with copious expectoration of "brownish stuff," and acute pain over upper anterior zone of liver.

I saw him, for the first time, in consultation, on January 25, 1922. The patient's appearance suggested profound toxæmia—pulse 110, temperature 102° (morning), dry tongue, incessant harassing cough, accompanied by much grumous ("Anchovy sauce") sputum. Marked upward increase of hepatic dulness, accentuated anteriorly, with diminution of tactile fremitus in front, and, if anything, increase of same posteriorly. Coarse crepitations and moist râles were audible over greater part of right lung. The continuous cough seriously handicapped auscultation.

These symptoms indicated a "broncho-pneumonia," of hepatic origin, without septic pleuritis. I diagnosed hepatic abscess in upper anterior zone endeavoring to empty itself *via* bronchus, and urged immediate operation.

On the following morning, January 26, 1922, ether was cautiously administered by open method, with patient supine on table, the chest was painted with iodine, as dulness was distinct up to level of right nipple, an exploring needle was inserted through fifth intercostal space (directly in line below nipple) and at a comparatively superficial depth the syringe filled up with similar stuff to that which he had been spitting up. Through a transverse incision over three inches of the fifth rib were excised, pleura and diaphragm divided; the upper border of liver was found densely adherent to diaphragm. The needle was again introduced, and at a depth of less than an inch an abscess cavity about size of a tangerine was struck. When this was exposed, examination of its interior by finger revealed a circular opening passing from its upper wall through diaphragm, of a diameter about that of a pen holder, situated on superior border of liver slightly internal to line of nipple, at a distance of an inch and a half from the anterior surface. The operation was completed in nine minutes.

By the third day cough and expectoration had ceased, temperature remained at normal. The man got out of bed February 12th, and was discharged cured on the 18th, 23 days after operation.

Seen July 8, 1922, "Never felt better in my life. I have had no more cough

HEPATIC ABSCESS EVACUATING VIA BRONCHUS

or malaria, and have gained three stone in weight." He still presents a weird display of superficial abdominal veins, some almost equal saphenous vein in size, but he thinks the edema of legs following walking is gradually getting less.

I think malaria has been maligned in this case. I have doubts as to its taking any part in the piece. Rightly or wrongly? I attribute the attack of dysentery which he had at Lagos, as responsible for the laying of the germ, which got to active business a few months after his return to Buenos Aires, and which culminated in rupture of a liver abscess into bronchus, December 24, 1921.

These abscesses, including hydatids, which trek through the diaphragm, without causing septic pleuritis, and discharge their contents by mouth are, I find, so frequently situated in the anterior segment of the superior border of the liver that it is imperative to bear this probable location in mind before commencing exploration. Although I had an early experience of this condition—published in the ANNALS OF SURGERY, May, 1897, I had been operating some years before I realized its surgical significance, and regret that it took so long to materialize (*British Medical Journal*, January 31, 1914) as more definite knowledge of the position of such lesions would have been helpful in the past.

I wish to impress on all who treat such cases to remember that, as often as not, it is a matter of life or death, and in order to enhance even a decimal chance of escape, it is essential to apply two vital operative maxims—every minute counts—undue exposure of the pleural cavity is fatal, consequently everything possible should be done to make the thoracic opening correspond to the most superficial site of the abscess cavity, in other words, to the point at which it may be most readily gotten at.

It is expecting too much of nature to eliminate a septic deposit handicapped by such drainage and infective difficulties, not to mention the gradual decline of general power of resistance caused by constant absorption of toxins.

It is necessary also to bear in mind that this class of abscess is frequently of small size, and as the contents are spat out, the cavity correspondingly diminishes. I have seen some collapsed, therefore failure with the exploring needle must not deflect, nor indeed defer, further surgical intervention as the chances are preponderant that death will supervene before the septic focus which is, now, being intensified by fresh infection from without, becomes obliterated.

Preliminary exploration with needle, always with the patient just under ether on the operating table, should be first made through (according to upward increase of hepatic dulness) the fourth or fifth intercostal space in right nipple line. If the needle, after various trials, fails to give the clue to the situation of a liver abscess or cyst which is obvious as such from the character of the expectoration, again guided by upward increase in dulness, and with the patient absolutely supine on the operating table, I remove three to four inches of the fifth or sixth rib in right nipple line, instantly incise pleura and diaphragm, and rapidly insert interrupted strong catgut sutures through the edges (*en masse*) of skin, muscle, pleura and diaphragm, and tie

SIR JOHN O'CONOR

same at once, taking care to leave sufficient room for the next manœuvre—introduction of right fingers between diaphragm and upper border of liver in search for the adhesion which obviously must exist in every case of hepato-thoracic fistula. The base of the adhesion points the site for the insertion of the exploring needle into liver where, invariably quite adjacent, the abscess cavity will be struck. The knife is passed in alongside of needle—the finger along blade of knife—two blunt hooks along finger—a large silkworm gut wisp inserted and fixed to skin, dressing applied, a pint of champagne siphoned into rectum, and patient hurried off to a warm bed in “the continuous outdoor.”

TREATMENT OF FRACTURED CLAVICLES

BY WILLIAM LISLE BELL, M.D.
OF OAKLAND, CALIFORNIA

If meagre literature in recent years may be accepted as an omen, we may reasonably assume that fractured clavicles are of minor importance or that the profession has accepted the treatment to date as adequate.

In this particular portion, if not all, of our country it would seem that (due to the X-ray) the patient is coming to demand in many cases more accurate approximation and more stable fixation than most of us are able to offer with Sayre's, Velpeau's adhesives, staves, Brown's shaped sheet metal, leather, wood, one-stage plaster, or anything short of open mechanical aid.

The treatment naturally depends much in a given case upon the age, appearance, sex, and expectations of the patient.

The muscular laborer cares little for anything save function and his heavy muscles minimize a lumpy bone. The young female, on the other hand, neither wants an unsightly scar nor a prominent callus. Conversely what is good for the comely young woman applies equally well to the muscular male.

Our point of vantage in this condition is based upon the fact that the shoulder joint has little tendency to ankylose or its muscles to fibrose as a result of its loose construction.

Hence our treatment may with reasonable safety rely upon immobilization of this joint in the proper anatomic relation, until our fracture zone is safely consolidated.

Our failures to get sufficient geography in our outer unit are due to the fact that we have thus far obtained a poor holding surface for this unit and have in addition not established a permanent base from which to work.

The problem is then, as I view it, to build a solid, dependable foundation around the chest, another movable unit around the arm, and, after completion of these two, to facilitate accurate and satisfactory relationship between the two units and maintain it with a structure equally strong and dependable.

Plaster-of-Paris offers the only workable substance to my knowledge.

In the beginning, attempts were made to hold the clavicle in apposition with a one-stage plaster coat, arm to above elbow, to base of neck on injured side, to three inches below nipple lines. (See diagrams.) This was found to be a tiresome effort laden with uncertainty. I never succeeded in getting satisfactory accuracy by this method and resorted to bisecting the case at a line which would about correspond to the shoulder sleeve seam in a coat. This was a troublesome procedure and was later modified to a two-stage method. In this the body case and arm case were applied separately. (See diagram.) When the plaster was properly set, either at the time, if the plaster was quick, or the next day if it seemed a trifle amorphous, with the body case as a base and a stable foundation, the arm and shoulder joint carrying the

WILLIAM LISLE BELL

outer clavicular fragment was extended (with counter-pressure against the chest case) outward, upward, backward. (It sometimes facilitates placing the outer unit, to cut a gap in the thoracic case over the acromion and inward to the point of fracture, wide enough to allow free elevation of the shoulder, but always leaving a wide shoulder strap of plaster over the shoulder and inner fragment at the base of the neck.)

When the outer fragment is properly extended, elevated, and placed (inner fragment may be manipulated under the case), a wiped joint of plaster-

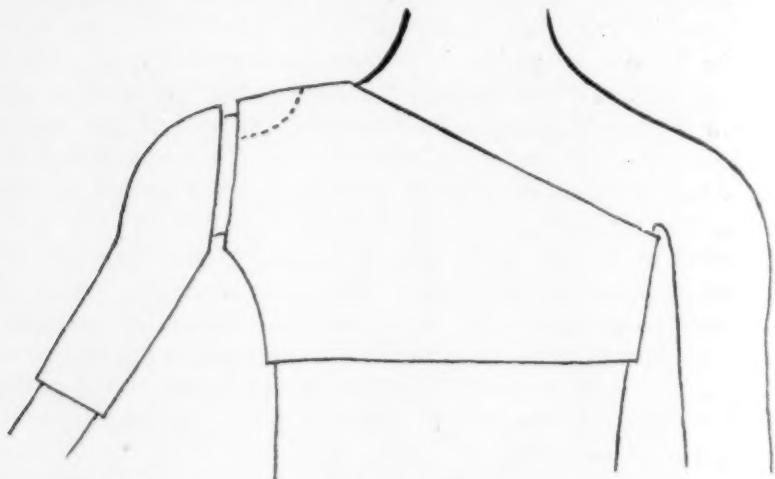


FIG. 1.—The two sections of the plaster casing.

of-Paris is applied around the gap between the body and arm case and this position scrupulously maintained until the extension ring or wiped joint has thoroughly set. Slight abduction of the arm fifteen to twenty-five degrees facilitates placing the circular plaster which of course covers ample chest, axillary and inner arm padding.

In passing it may be mentioned that this same device has answered most happily in a few very painful acromic clavicular luxations and in one, a double-ended clavicular luxation that had proven so painful for some weeks that open operation was asked for. The relief from this device was so immediate and so satisfactory that the patient went to duty in a week wearing the case and wore it for some three weeks longer.

In applying the case I like to smother the patient in sheet wadding, not too thick but wide of the mark with abundant thickness over axilla and inner side of arm. The first layer of plaster is then put on very smoothly and snugly as to the chest, not tightly around the arm. Five to seven thicknesses are ample. When arm case and chest case are sufficiently strong, extension is almost startling. This is due in a measure to the fact that the chest portion recedes against the chest wall and the arm case becomes eccentric due to the outward pull.

I have used this device now in five cases, one a neurotic female, one a

TREATMENT OF FRACTURED CLAVICLES

small active boy of nine, one a female, age sixty, one a very muscular teamster, one an ununited of one year from a gunshot wound. All of these cases except the last had been bound for some time in bandages, adhesive, pads, slings of varying design and thickness, and all these fractures overrode decidedly up to two centimetres. All these patients agreed most emphatically that discomfort was practically negligible, that they could jam through crowds without pain, could sleep in any position without discomfort and above all could use the forearm throughout. In all of these five cases no forearm ana-

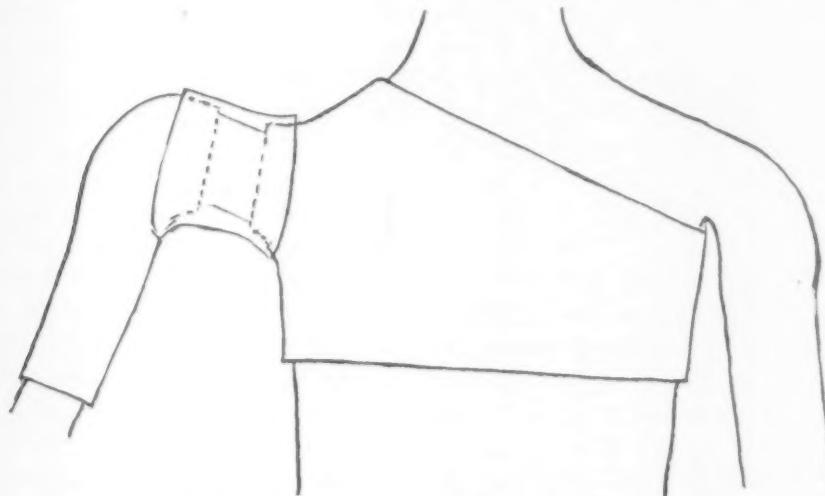


FIG. 2.—The third plaster section securing the bone fragments in position.

thesias developed. No oedema of the extremity, no atrophy of forearm and practically none of arm, due no doubt to the wide excursion permitted the triceps and biceps through full forearm mobilization.

In the fifth case, an ununited clavicle of one year, a small ox-bone intramedullary with a Delangeniere, gave surprisingly rapid consolidation. In this case a port was cut over the incision to facilitate dressing. This can be accomplished down in front parallel with the clavicle, leaving intact the shoulder cap (on top) which maintains all the required points of support and does not weaken the case appreciably.

It might also be mentioned that several types of parallel barred wooden splints, an Armor splint adjustable after the Brown type, and a molded A type were used without success.

The Armor type of pressed adjustable metal is cumbersome, complicated and expensive. The wooden bars and cross-arms require a lot of rigging, and none or all of them answered the requirements of lightness, cheapness, comfort, freedom of forearm excursions, permanency of immobilization and readiness at all times.

Always an infrequent user of plaster and a believer in mobilization wherever half possible, a follower of Lucas Championierre, Willems, Hey Groves,

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and Mennel, it required some little denial to mold one's ideas to this rigid looking casing. After a few trials, even of the more crude earlier models, the dependability of the thing and its freedom from constant tinkering and makeshift changes brought home its advantages.

When thoroughly hardened, half-inch holes may be bored promiscuously all over and through this shell and ventilation established through the lining.

It is a good practice also to dry the case as it goes into an electric portable hot-air blower, manipulated by an attendant. This seems to make for a tougher case and a more sanitary interior.

COMPRESSION FRACTURES OF THE LOWER END OF THE RADIUS

BY JAMES H. STEVENS, M.D.
OF BOSTON, MASS.

THERE are few points in the technic of reduction of Colles fracture of the wrist which we call compression fractures of the lower end of the radius which have not been touched upon by some author since the classical description of this injury by Colles. In an article of ours, in the ANNALS OF SURGERY for 1920, we proved that there was a great misconception on the part of the profession regarding the question of impaction in these fractures. We proved that impaction, if by impaction we mean any considerable amount of telescoping, does not exist, but that the real pathology consists of a crumpling up of the posterior cortical surface of radial bone; a crush—a collapse which permits perpetuation of the reversal of angle as we call it, or reversal of the plane of the inferior radial articular surface.

The ordinary fracture of this type without displacement of the fragments and without the evidence of great compression which has been wrongly called impaction by most authors, is not a fracture of great importance if properly treated, although the end results if improperly treated, or as at present treated, are about the same as the more serious type so far as restriction of flexion at the wrist is concerned. This, however, has been the result of immobilization for weeks at a time and would never have resulted in a restriction of motion had they been treated by immediate mobilization. In other words, the bad repute of these fractures at the lower end of the radius has been the result of the treatment and not the result of the fracture.

There is the other type, however, showing clearly the effect of a tremendous compression. The distal fragment is displaced backward and the so-called impaction is clearly in evidence.

With this fracture, which we have contended should be called compression fracture of the lower end of the radius, there is always (in the major cases) this crushing or crumpling up of the cortical bone, exactly as happens in wet timber when subjected to compression. The crushing up is always on the posterior or posterior and external side of the radius, because this is the compression side of the bone undergoing stress, and compression is much greater than tension, so that the bone instead of breaking in tension as in a cross-breaking strain, breaks always in compression and results in this crumpling up which changes the angle of the articulation.

If an X-ray plate of these cases is taken after reduction, although the fragments are perfectly movable under the fingers, the reduction having been easy, nevertheless the X-ray clearly demonstrates that the reversal of the antero-posterior angle or plane of the inferior articular surface of the radius

which is normally between fourteen and twenty-two degrees in front of a line erected at the level of the anterior edge of the radius, still remains in all the cases of the serious type. In other words, the antero-posterior plane of the radial articulation had been reversed and in all of the cases remains reversed, even after reduction.

What do we mean by reversal of the antero-posterior angle? Let us look at the X-ray plate of a lateral view of a normal wrist and draw a line straight down the middle of the shaft of the radius (Fig. 1). At the level of the anterior inferior edge of the radial articular surface, let us erect a perpendicular to this first line and carry it through this line an equal distance posteriorly. We shall find that such a line cuts the posterior surface of the

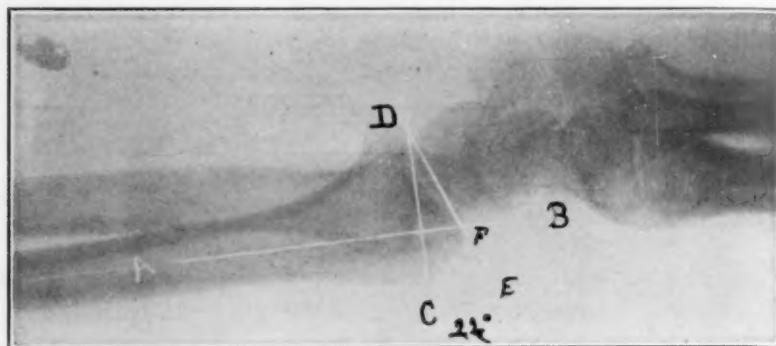


FIG. 1.—The normal antero-posterior angle showing C D E the angle. D E is always in front of D C. The line A B if drawn through the centre will always cut the line D E in the normal bone at a point which will be much nearer to the inferior posterior edge of the articulation F. This is a diagnostic point. Many times as in the above such a line will cut exactly through this point. Where A B cuts D E midway between point D and F it is usually proof of a good deal of displacement. See Figs. 5, 10, 13 and 15.

radius some distance above the articulation. In other words, the normal plane of the articular surface is anterior to this line. Now if we draw another straight line, beginning at the anterior inferior edge of the radius at the same point anteriorly, where we began to erect our perpendicular and draw it just touching the edge of the posterior inferior articular surface of the radius, we shall find that this last line, representing the slant or plane of the inferior radial articular surface will always form an angle with our perpendicular of from fourteen to twenty-two degrees of the arc of a circle and that this angle is always in front of the perpendicular. This, then, is the normal antero-posterior angle of the lower radial articulation and it is usually about eighteen degrees.

The same may be done with the other view, as we have shown before, but that is another matter and has no bearing on the particular point which we wish to make here.

These lines to which we have many times called attention are never absolute, but for practical purposes they will serve, and because they are not absolute, it is necessary that especial care should be taken with the

COMPRESSION FRACTURES OF THE LOWER END OF THE RADIUS

X-ray plate because, by varying the distance and position of the tube with respect to this lower end of the articulation, we are able to distort our image so as to make it difficult for us to draw conclusions which are accurate. That

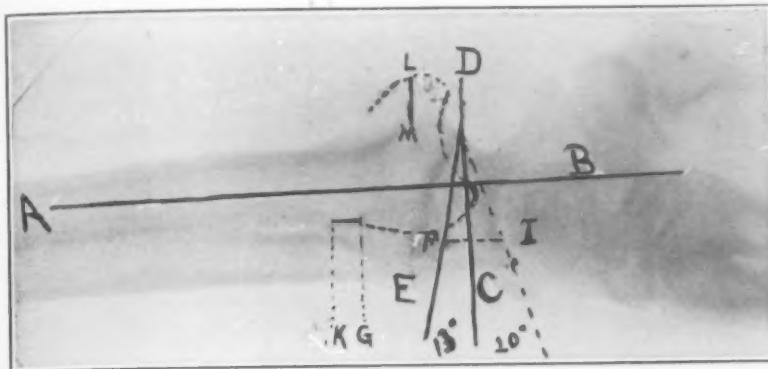


FIG. 2.—Reversal of angle, C D E. Note that the line D E is now behind D C. To estimate its change draw the dotted line in front of D C, at twenty degrees. This will be the plane of a normal restoration and the fragment must be forced forward and upward so that D E will be in front of D C in our final result. The better the restoration the nearer will the line A B come to point F. It will be clearly seen that while D I the dotted line is the plane of the normal joint in this case, it does not mean that the fragment must be forced forward until point F is at point I, because the entire fragment must be lifted up the distance which it has dropped L M. And as the posterior inferior edge F is turned forward a sufficient distance to obliterate the crush K, G, the anterior edge is turned backward an equal distance. The correct position for this case is shown in the outline in dots, of the restoration as it should have been. This is why F, I as drawn for estimate only, is twice K G always. And this explains why we have all of us in the past failed to restore this normal angle. We have been content to unlock the fragment and try to push forward the posterior edge which was equally important and we have failed to lift our fragments enough. Worse than all. Had we succeeded in properly reducing them, we would not have held them with the type of splint which all of us have used.

is the wrist must be taken in a perfect lateral position, the two bones superimposed and the distance from the tube must be always the same. We have suggested a distance of three feet, and the tube must be centred by a plumb-

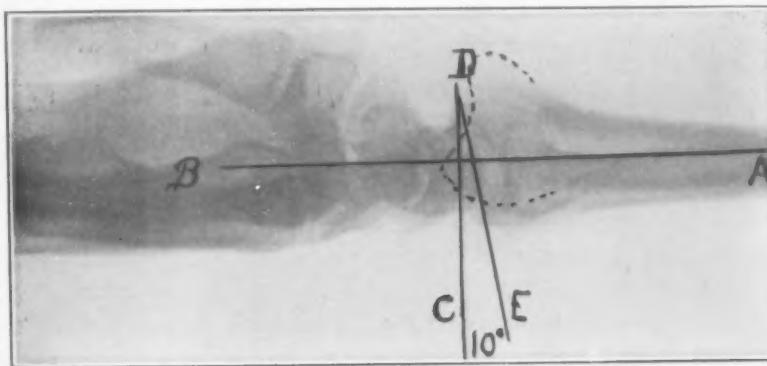


FIG. 3.—Another so-called good reduction and it is true if we judge by the majority. Ten degrees reversal. The dotted lines show where it should really be.

bob over the lower expansion of the radius. If the tube is centred lower down over the hand, we shall have an oblique shadow of the whole radial articular surface thrown on the plate, and this is exactly what we wish to avoid. If we follow instructions carefully in every case, we shall have a

clear picture of the antero-posterior slant of this articulation, and we shall then be able not only to draw conclusions, but to actually measure in centimetres if we so wish the amount of change which we will have to overcome in the reduction of these crush fractures of the lower end of the radius. (See Fig. 2.)

The angle measured in the X-ray plate now shows that it is reversed; in other words, the line representing the plane of the articular surface which in the normal was fourteen to twenty-two degrees in front of the perpendicular line is now behind it, and often an equal distance behind and even after so-called reduction this reversal of angle persists. There has been an actual destruction of bone on the posterior surface of the radius and the

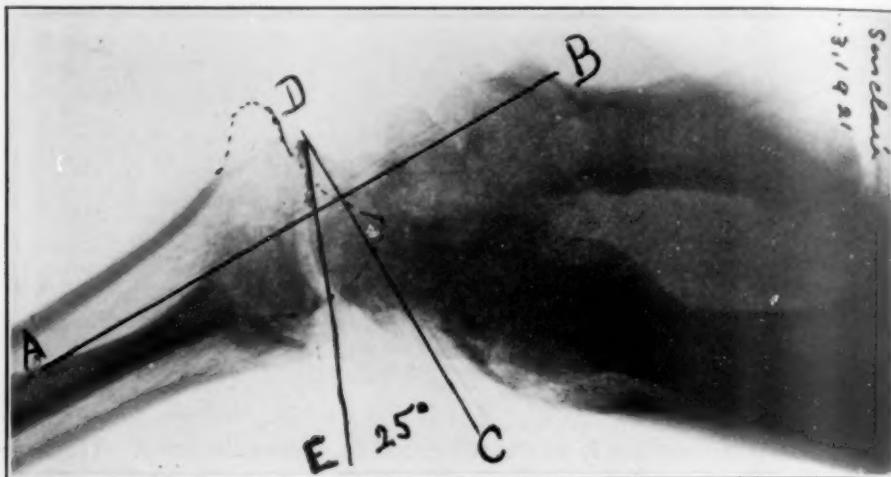


FIG. 4.—Do these cases represent unusual results? Here is another and this one is from a great metropolitan hospital. Would our country cousins do any worse? There are many like this. No attempt was made to better this first reduction. Picture two months after injury, when case was referred to us. Not printed in criticism, but to call attention, that even this type is common and not confined to the small surgeon. We are all vulnerable.

inferior fragment has consequently tipped backward and has been displaced in this direction. It is held rigidly by the bow-string tension of all the extensors, as we pointed out in the article before mentioned. The classical reduction releases the tension of these bow-strings and with comparatively little force the distal fragment can be moved forward approximately into its normal position. The fragment is freely movable. The silver fork deformity has disappeared and apparently there has been a perfect reduction. An X-ray is taken and a good reduction is reported, principally because the shaft of the radius seems to be in fairly good alignment. Little attention in our experience is paid to the fact that there still persists a reversal of the normal antero-posterior angle of the inferior surface of the radius. Now if this were due to impaction, the impaction obviously having been broken up, a freely movable fragment resulting, there would now be no evidence of this so-called impaction.

We have examined a great many X-ray plates of cases treated in the hospitals and outside, by a large number of different operators, and never

COMPRESSION FRACTURES OF THE LOWER END OF THE RADIUS

in our experience have we been able to find a case showing this evidence of compression where the normal antero-posterior angle has been restored.

This means, of course, if permitted to remain as it is in every case that I have had occasion to verify, the perpetuation of a certain prominence of

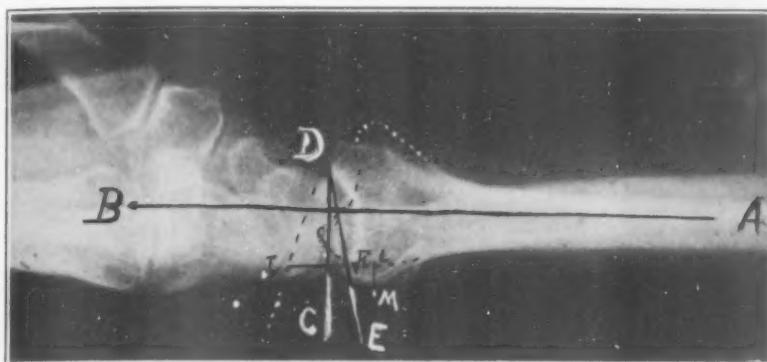


FIG. 5.—Almost reduced. Called a fine reduction and it is reproduced here because it is a better reduction than ninety-eight per cent. of cases. Nevertheless twelve degrees of reversal remains. Why? Because it was not lifted the distance it had dropped, L M. Point D was not pushed back half the distance represented by F I, and point F was not pushed forward an equal distance. The line A B passing nearer to point D than to point F, was enough to show that the reduction was not satisfactory. The dotted outline of bone shows this fragment where it should be if really reduced.

the front of the wrist; of a certain amount of increase in the ability to hyperextend the hand and a certain amount of limitation of motion in flexion even where recovery of motion has been good.



FIG. 6.—The wrench and its method of application used only after fragment is freely movable. It is not often necessary to use it at all. But it is valuable. The hand in this position pushes back the anterior edge of the broken fragment. The posterior prong raises the entire fragment and forces forward the posterior edge and the anterior prong of the lever pushes back the lower end of the upper fragment or shaft now to hold it.

The X-ray man says that the reduction is good, because he never sees any which present any different picture. The surgeon has felt the fragment swing freely into place and he knows that he has reduced it and that if it is freely movable certainly the impaction must have been overcome. For many

years we felt the same way about it. We knew also that with the treatment which we have advocated for many years, that is, mobilization quickly of all these wrist fractures, we could get in nearly every case practically a normal motion at the wrist even with the persistence of this reversal of angle. With immobilization even for three or four weeks of time in these cases, or in any case, there is usually restriction inflexion of the wrist and

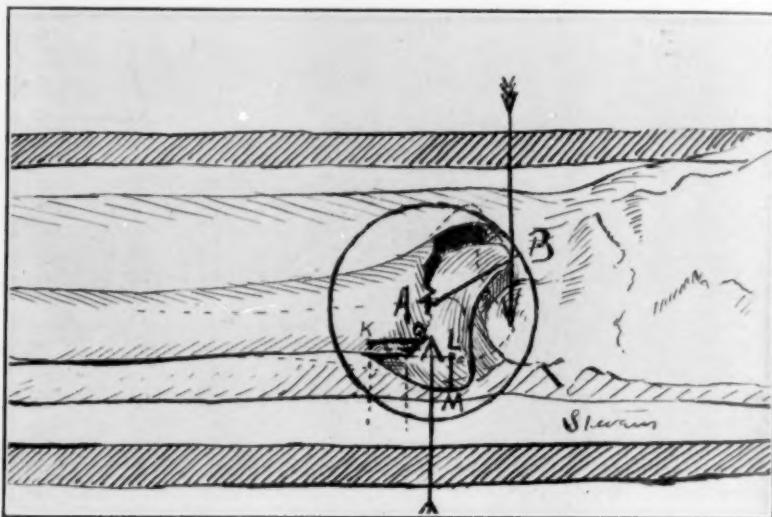


FIG. 7.—Showing the two points of pressure, with long anterior and posterior splints in place. With anterior splint alone the same picture is present, enhanced because the posterior lifting force is removed. Even with padding well back of the fragment there is no force tending to lift the fragment and turn it forward into place. Both these types of dressing tend to perpetuate the reversal. Note how the fragment if considered as a part of a wheel would turn, the posterior part down and back, the anterior down and forward, thus increasing the slant out of all proportion to the compression in evidence. This shows when the apparent crush K G is measured and it is found that twice this distance will be necessary to restore fully the angle. The tremendous distance which the posterior inferior edge of the distal fragment must be swung forward and upward in order to restore the normal plane, it must be remembered, is more apparent than real, because as the posterior edge swings forward and up into replacement, the anterior edge swings backward and upward thus diminishing the distance which the posterior edge would have to move to accomplish full replacement. The fragment must be lifted up the distance it has dropped, L M, the posterior edge turned forward a distance equal to K G, and the anterior edge turned backward an equal distance. Reposition on this basis is outlined in dots to show the correctness of such an hypothesis, the so-called impaction posteriorly being in reality crush. It is clear that after reposition the slightest pressure in a downward direction on B would cause the reversal to reappear.

this restriction persists because the restriction in motion is due to immobilization even more than to a changed articular plane.

It is a rare thing to examine an old case of fracture of the lower end of the radius without finding some restriction of motion, especially in flexion. Ninety out of one hundred cases treated by the old method will show it, and this applies without regard to where the case was treated or who was the attending surgeon. Many times the patient himself is unconscious of this loss of flexion at the wrist; the flexion of the fingers fully compensating for the loss, but if flexion at the wrist is made with the fingers in extension, there will show clearly a distinct loss in flexion.

Only a short time since we were consulted by the head of an insurance

COMPRESSION FRACTURES OF THE LOWER END OF THE RADIUS

company which specializes in cases of this kind. He had suffered a fracture of this type two years before and had been treated in one of our best institutions. He was not aware of any restriction to flexion at the wrist, and, knowing that I was particularly interested in these cases, he called my attention to the beauty of the result in his case. The flexion of his carpal bones was only forty degrees at the wrist, but as he always flexed his fingers strongly at the same time he was absolutely unconscious of any loss of flexion.

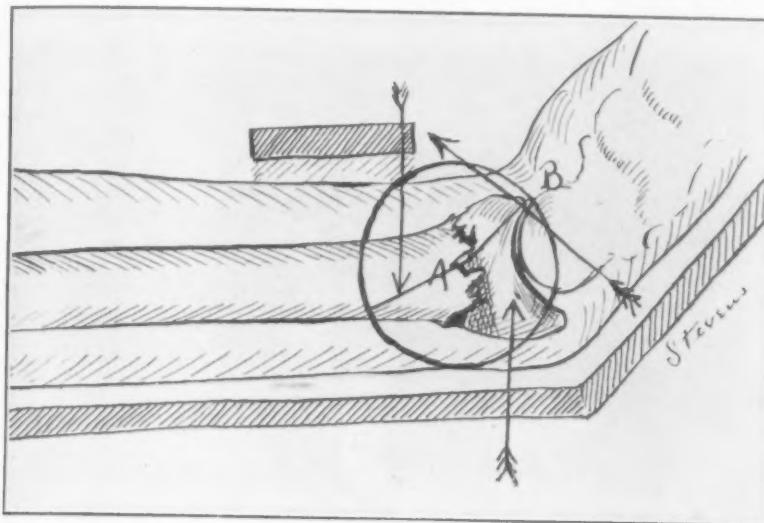


FIG. 8.—Showing the three points of pressure with our angled posterior splint, and a small anterior pad. Imagine the broken inferior fragment, as a part of a wheel, and force applied to its rim in the direction of the three arrows. In what direction would it turn? The radius of our wheel is the line A B and the fragment is not only turned, but is held in place and the reversal of angle overcome. No form of straight splint anterior or posterior will accomplish this, and no form of specially moulded anterior splint alone will do so. The angled posterior splint is the logical solution and the angle is varied to suit the individual case.

It goes without saying that I did not enlighten him because it is our contention that this same restriction of motion is present in the great majority of cases which have been treated by the older conservative methods, without regard to the severity of the injury.

This applies more particularly of course to those cases showing reversal of the angle or plane of the articular surface, which is an important feature in any fracture involving the lower end of the radius, but it does not exist unless there has been a tremendous compression.

Why do these X-rays after reduction with the anterior and posterior splints, or even with the anterior splint alone, in position still show reversal? Not occasionally, but all of them. There are two reasons. First, because there is crush, loss of substance of cortical bone on the posterior side of the radius, and therefore a slight pressure anteriorly upon the fragment will always tend to tip the anterior-inferior edge of the radius downward. Second, the straight position of the hand tends to separate more easily the anterior surface of the break and to push backward the posterior surface, thus perpetuating the reversal, or even recreating it. The anterior-inferior edge

JAMES H. STEVENS

is turned forward an equal distance as the posterior edge is turned backward, and in the horizontal position both are on a lower plane than normal, and this is not restored.

It is not our purpose in this paper to enter into a long discussion of the mechanics or treatment of these fractures at the lower end of the radius, or to deal with the lateral deformity which is overcome with comparative ease, because we have already done that in the article to which we have referred; but we wish to call attention to a method which we have found

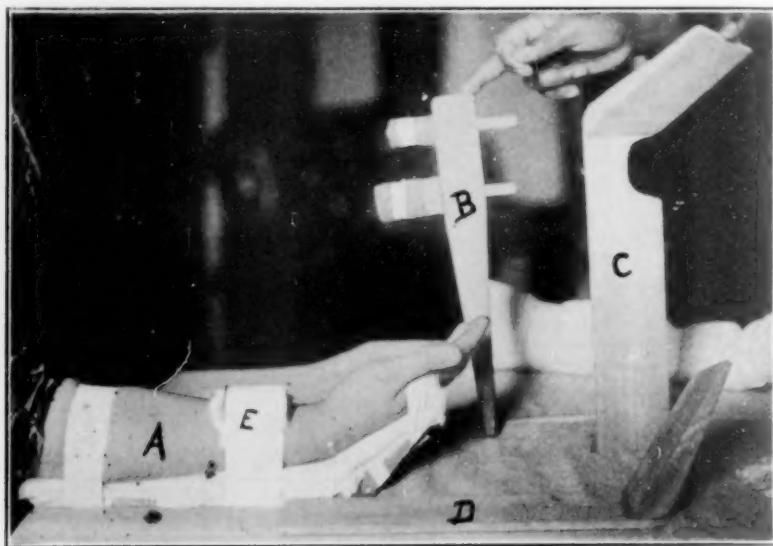


FIG. 9.—A completed dressing without the bandage. B wrench sometimes used. C splint unpadded, forty degree flexion, thirty degree adduction. D splint unpadded, forty-five degree flexion, thirty degree adduction. The splint used here was thirty-five degrees in flexion, thirty degrees adduction. Note the small anterior splint. This shows how simple it is to remove enough dressing for early mobilization and how easy to change the pressure at any time or if necessary to change to a greater or smaller angle. With plaster-of-Paris it is inconvenient and such a dressing has the disadvantage attached to any long anterior splint. A plaster dressing of a radial fracture in flexion and adduction will restore the angle, but it will be much more easily handled by this wooden splint, and the pressure at E can be adjusted as necessary.

valuable in the treatment of those cases of reversal of the angle, which if permitted to remain, means always a slight deformity at the wrist, even in those cases where restoration of motion is good.

There were two statements which we made in regard to this fracture in the ANNALS OF SURGERY for 1920 which we would like to modify slightly. First, we said that the old method of reduction by hyperextension, local pressure downward and forward with the thumb and then strong flexion at the wrist, had not been improved upon in any way. In the ordinary case even with posterior displacement of the inferior fragment where there is little crush, this is an absolutely true statement, but in those cases showing a great deal of crush, and persistence of reversal, we believe that we can overcome this to a great extent, and it is incumbent upon us to work always towards the anatomical normal, because only in this way can we ever attain an absolute

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physiological normality. Good enough is a bad combination. What we want is as near perfection as it is possible to attain.

The unlocking of the inferior fragment of the broken radius is easily accomplished by hyperextension, thus releasing the bow-string tension of the thumb extensors, the extensor carpi radialis longior and brevior, the extensor

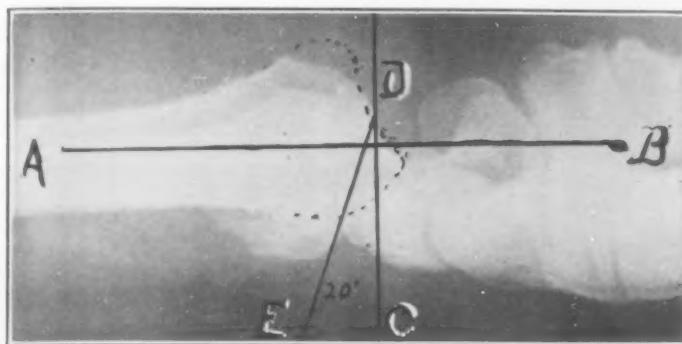


FIG. 10.—Original injury. Twenty degrees of reversal. Dotted outline shows approximate position of normality to be attained in this case. Compare with Fig. 12, showing final result.

indicis and the tendons of the common extensors of the fingers. Local pressure over the fragment with the thumb, traction, and then strong flexion of the wrist with the fingers extended, flexing the wrist to a right angle. I cannot get away from the feeling that this is the important movement in

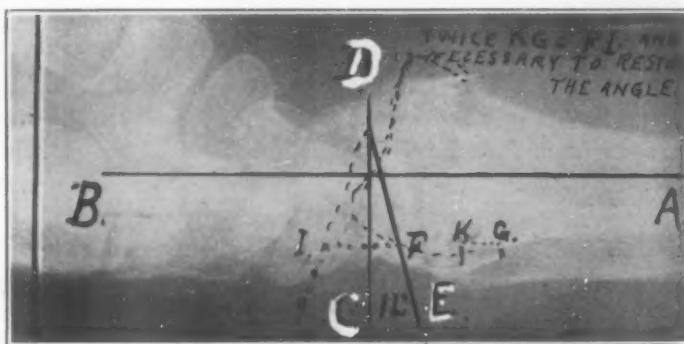


FIG. 11.—Reduction. The fragment is freely movable. The silver fork has disappeared. This was called a good reduction by the X-ray experts and it is such, judged by the usual standards. The angle is still reversed, and is so in any of these cases as ordinarily treated. This applies to large surgical centres and hospitals. In other words they are only half reduced. See Fig. 10 for original injury.

reduction and that flexion afterwards will be exactly proportionate to that degree of flexion which I have attained forcibly at the time of reduction. Circumduction movement is of no importance, but a strong adduction should always be used to reduce lateral displacement and in order to restore the lateral angle which is often disturbed. In the majority of cases this will suffice, for the reduction, but, nevertheless, they will still show the reversal

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of the antero-posterior angle, and sometimes to a tremendous extent. While we can return these wrists to practically the normal range of motion, almost as quickly as the apparently much less seriously injured, nevertheless, with this persistence of reversal there must always be at least a slight deformity and a slight limitation.

In the article which we have mentioned several times, we made the statement that by extension and restriction of motion by splinting in a fixed flexed and adducted position over a long period of time, we could restore this angle, but that such a restriction would be followed by a greater disability to the injured wrist than if treated otherwise, because the main requisite of all these



FIG. 12.—Restoration of the angle to twelve degrees, by flexing and using our post-angled splint. Note that there is only a 2 x 2 inch anterior splint and that it is well proximal to the fragment so that no pressure is on the anterior side of the fragment. Note how the crush so prominent in Figs. 10 and 11 has been straightened. Position was all that was necessary. The lever was not used. Angled splint still in place. Fig. 10 shows the injury. Fig. 11 shows the reduction with straight splint in place.

injured wrists is motion quickly. If he gets that, we shall have a return to practically a normal mobility at the wrist very quickly, and, after all, the main desideratum in all these injuries is recovery of motion. A little deformity is not of great importance, except to a woman, but a loss of motion is a calamity. Were we to have our choice between the two, we should always sacrifice looks for mobility. Is it not possible to accomplish both of these much-to-be desired results? The logical position after the reduction of fracture at the lower end of the radius is flexion in adduction; and while we have repeatedly stated this, we have only comparatively recently resorted to it in these cases of reversal. In the cases without reversal, it is not a necessity. We said in our previous article that almost any splint would suffice, and it is a true statement in those cases which do not show this reversal, but we have proven to our own minds, that it is not a true statement in those cases where the angle is reversed. To-day we do not use a long anterior splint at all. A small piece of splint wood two by two inches, which is placed on the anterior surface of the wrist and which must be placed well above the distal fragment so as not to bring pressure upon it in any way, is the only form of anterior splint which is of value. Pilcher, in a most able article several years ago, called attention to the danger of a long

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anterior splint and to the careful padding necessary to prevent pressure on this fragment by the anterior splint, especially in those cases of posterior displacement of the inferior fragment of the radius. If you will look at Fig. 7 you will see how with such a fracture the tendency to backward displacement of the distal fragment is accentuated, unless one is particularly careful, and an anterior long splint will exert pressure upon the lower anterior end of such a fragment tending to perpetuate its displacement, with the resulting perpetuation of the reversal of angle or even tending to renew such a displacement once it has been reduced. Apparently very few in the profession saw the great desirability of avoiding this pressure. We hold that it is not

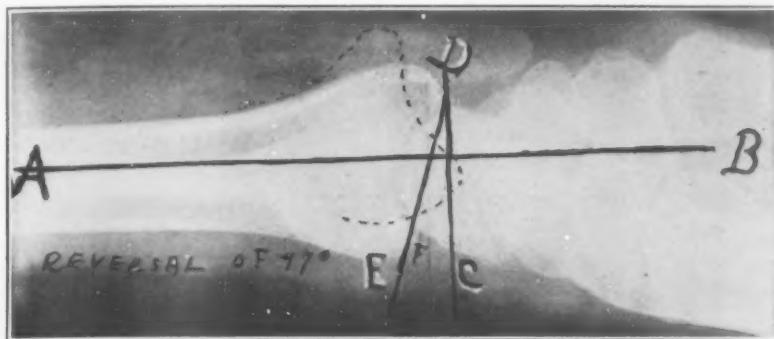


FIG. 13.—Reversal of seventeen degrees after the reduction which was called good. AB much nearer to D than to E. Dotted lines show approximate normal which should have been attained or at least striven to attain.

possible to avoid this entirely, except by discarding the long anterior splint and this applies to all types of long anterior splints.

This type of splint is not only not a necessity, but in all cases of reversed angle it is a distinct menace. There are no advantages in any case, and their use is fraught with danger in those cases where there is the evidence of great compression and posterior displacement of the inferior radial fragment. In the simple cases, therefore, a posterior splint well padded with a large ulnar cut out to prevent pressure on the head of the ulna and a small anterior splint two by two inches, which is placed well back of the large bony prominence of the radius. If placed over the fragment, it perpetuates the deformity. If placed properly well back of the radial prominence, it tends to push backward the proximal end of the broken radius, while the posterior splint tends to push forward the lower fragment. Where there is no need of any correction, the anterior splint is of no value anyway and may be discarded, and this is advantageous because by the use of plaster without an anterior splint, we can keep the ulna more firmly against the lower end of the radius and aid in the restoration of these inferior radio-ulnar ligaments which are always damaged. This pressure tends also to push backward the ulnar head which is normally posterior and thus preserve the normal ulnar prominence.

In the cases with reversal of the angle, what shall we do? If we carry

the hand into extreme flexion and adduction and hold it in that position while we take an X-ray, we shall find that much of this reversal of angle has disappeared. The problem then is to hold it there, and since if we use a straight posterior splint as before in this case, we must of necessity straighten the hand and thus permit the sinking backward of this distal fragment to a certain extent. We cannot do it. Any type of long anterior splint simply accentuates the recurrence. These cases with reversal of the angle are seldom more than half reduced. They must be levered upward to straighten out the crush and force them into position anteriorly. And this is what we do when we forcibly flex the hand. Now we must hold it (Fig. 8). As we

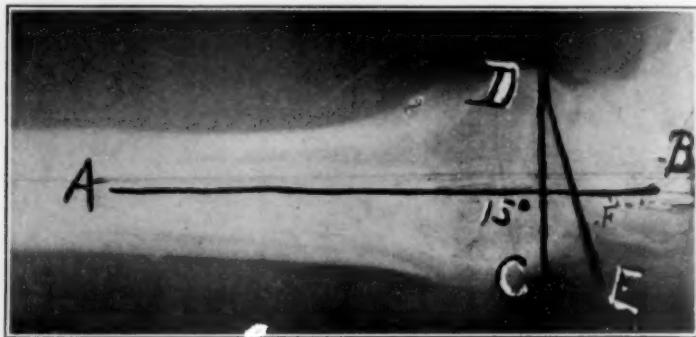


FIG. 14.—Restoration to fifteen degrees. F is nearer the line A B than D. This fragment should have been lifted more.

have said, this crumpling up of the fibre is akin to the compression breaks suffered by wet timber when broken under compression, and that, exactly as in timber, there is destruction of cortex which it is impossible to absolutely restore, but exactly as we can in the straightening of a beam of timber after compression fracture, partially restore it, so to-day we believe that in these cases by the use of a special posterior splint which holds the wrist in a position of flexion and adduction we can do away to a great extent with this reversal of angle without interfering, except to a minor degree with our treatment by early mobilization. Such then is the type of splint which we have devised for all these cases of reversed angle (Fig. 9). The short side of the splint reaches from the wrist to the proximal ends of the phalanges. It is angled at the wrist thirty-five to forty-five degrees in flexion and thirty degrees in adduction. There is an ulnar cut out and the splint is narrower than the wrist.

This prevents the tendency to separate the radius and ulna which is present where wide splints are used, especially when both anterior and posterior splints are employed. Keep the ulna and radius together at their inferior articulation so that the torn inferior radio ulnar ligaments may heal.

We have reduced the fracture, the inferior fragment is freely movable and we have pushed it forward into place. Remember that nearly always the fragment is permitted to remain too far posteriorly. The operator is afraid

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of pushing it to the front too far, and therefore often he fails to fully reduce. Push it forward firmly. Flex the hand to the limit at right angle to the wrist. Adduct to the limit to restore the lateral plane of the articulation; mould locally with the fingers, and put on the posterior splint—angled as shown in the illustration. Figure 9 shows the splint applied and study of this illustration will demonstrate the method of application. Take an X-ray, immediately for verification. Where the crumpling up has been tremendous and there is difficulty in reduction, the implement represented in Fig. 9, B, which we use and have found efficient, may be used, but remember that this implement is never to be used until the bow-string tension has

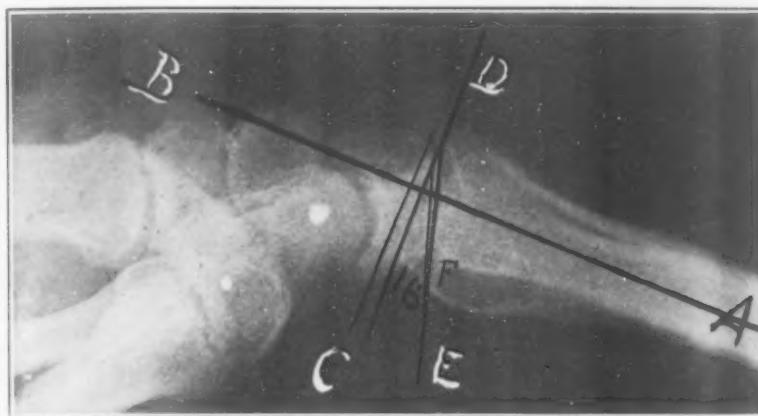


FIG. 15.—The silver fork is obliterated, and reduction was called good but it is not. Sixteen degrees of reversal. Note how the line A B is still nearer to D than to F.

been released. It is the last thing to use in order to obliterate the last vestige of reversal of angle. It is never to be used as an instrument for reducing the fragment. If used in that way, a great deal of damage could be done by accentuating the crushing. The instrument is used exactly as shown in the illustration, Fig. 6, and may also be used for restoring the lateral plane or angle as well. It is applied after the fragment is free, exactly as shown, one prong well padded resting against the inferior fragment posteriorly and one resting against the proximal fragment anteriorly. By leverage gently, but firmly, we can now pry up the posterior surface of the displaced fragment while exerting pressure backward against the proximal shaft of the radius, until the normal prominence of the inferior radial articular surface is restored. Nearly all of these inferior fragments when displaced are only partially replaced, and by this manœuvre of leverage we can force them far forward into position in spite of the posterior crumpling of cortical bone. Do not use too great a force. The leverage stick is only for the unusual case. The usual case can be reduced without it. The crumpled up cortical bone is straightened, but there is always a loss of substance posteriorly, and if now we put on an anterior straight splint, we shall not only not hold the reposition, but we shall

inevitably tilt the fragment backward again to an extent sufficient to recreate the reversal (Fig. 7). Hold the position by the application of the special posterior splint, and place anteriorly a small well-padded strip of wood slightly narrower than the arm at this point, and two inches in length only. Be sure and get this above the lower fragment. If you place it over the fragment, you will undo all that you have done. Get it well back above the normal prominence of the lower end of the radius. Do not expect that you will absolutely restore the normal angle in every case, but you will be able in most of them, to so correct this displacement, that the line representing the plane of the articulation will always be in front of the perpendicular, and if

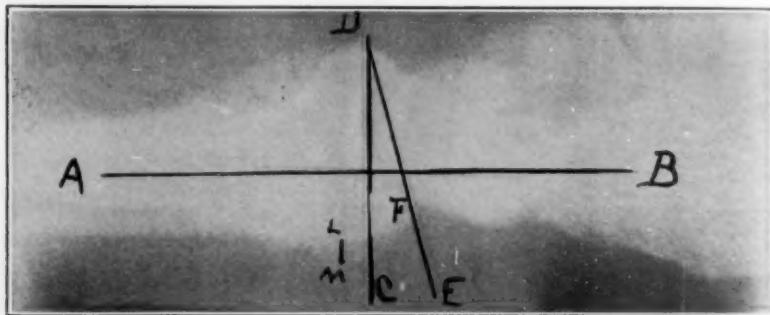


FIG. 16.—This shows what the wrench and angled splint accomplished. Sixteen degrees in front of D C means normality practically. The reversal of this plate is because it was printed from the other side of the film. L M still show the amount of drop which would have meant perfect reposition.

you accomplish this, you will have restored this joint to a practical anatomical normality. If you will glance at the illustrations you will see in Fig. 10 the original injury. Reduction had been attempted and as can be seen had failed. Reversal of the angle is still present; the plane of the inferior articulation is decidedly changed. Figure 11 shows the first reduction by the old method and was called a good reduction by X-ray men who are expert in this line.

Figure 12. The third plate taken shows what was accomplished by the changing of the posterior straight splint for our posterior angled splint. No leverage was necessary. This reduction was accomplished in the service of another surgeon, and the follow-up was not in our hands. It shows a slight spicule of bone anteriorly which is of no importance but which could have been pressed back into place by simple pressure at a subsequent visit. The main point to be observed is that the normal plane of the articular surface of the radius is restored, not to the same extent as before injury, but to a greater extent than we believe possible by any other method. (See Figs. 13, 14, 15 and 16.)

Now the most essential feature of the treatment of a fracture of this type is motion quickly as we have pointed out many times. Shall we jeopardize the position which we have gained in these cases by motion quickly? If this were a fact we should prefer to leave the cases with the angle reversed,

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because, even with a reversal of angle, by mobilization quickly, we can restore nearly all of these cases to a practically normal motion at the wrist by the twentieth day. In our first cases, this was exactly what we feared, but we found that our fears were groundless. We must be more careful in instituting passive motion, that is all. Motion is begun in these cases not later than the fourth day, but the posterior splint is left in place during the motion, the hand to the wrist being freed and moved gently in flexion and adduction. Extension in these cases is not carried beyond the posterior splint, until after seven or eight days, and even then the wrist is not extended beyond the horizontal plane for some days longer. By this time there has been a filling in of the posterior gap in the bone by soft callus and it is sufficient to retain the position. Abduction is left to the last. By even a few degrees of motion one can accomplish almost as much as by the fuller arc which is employed in all cases not showing this angle of reversal.

We have repeatedly said that an ordinary fracture of the lower end of the radius with any retention or restriction apparatus after the tenth or twelfth day, except a leather wrist strap was a case maltreated. This is true of nearly all of these cases, but in this type where reversal of angle has been great and we have succeeded in restoring the angle to a practical normality, we have added a few days, and it is usually about twelve to fourteen days before we discard entirely the posterior splint. It is possible that with an increased experience we shall find that we may be able to dispense with it at an earlier date—exactly as we do in those cases which do not present this compression feature. Although we are forced in this type of case to the use of a smaller arc of motion, nevertheless, by the use of that arc of passive and active motion each day, we have preserved the normal ability to flex and extend the wrist and a few days more or less are of little moment in the treatment of this injury. By the twelfth or fourteenth day, these cases have only a leather wrist strap, with an ulnar cut out for protection and their final recovery is no less rapid than the others. From this time on, they use the hand for all ordinary purposes which are not accompanied by strain, but with care and common sense. An individual with a fracture of this type is not expected to throw a base-ball on the twelfth, fifteenth or twenty-first day, and it is not necessary that he should. If he is the type of individual who expects to do these foolish stunts, and there are some who do, or the type who is not intelligent enough to understand the limitations, then he must be restricted for a longer period and so protected against himself. This is unfortunate, but since the passage of the State Compensation Acts have taken away from a certain class of lawyers their ability to blackmail corporations, they have been diligently searching for new fields and the surgical profession has not been overlooked. Therefore, one must be careful, because the medical man may be held responsible for the result of the patient's own folly. A short time since I found a laundry worker who had suffered a fracture of this type and whose wrist I had put into a leather wrist strap on the twelfth day, shaking sheets on the fourteenth day, although she had

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been fully instructed as to her limitations, and the foreman of her workroom had also been cautioned as to the exact type of work which she should do. Fortunately no harm resulted, but I was informed that she had insisted on this work on the very day that the retentive splints had been removed. There is, unfortunately, also, in our community, a certain type of medical men, who, slow to learn and adopt anything new themselves, are only too prone to throw all manner of obstruction in the way of others.

Reduce the displacement, begin motion early, and get away from all retentive apparatus as quickly as possible in these joint injuries, and we shall no longer have wrists which show a permanent disability following even the simplest of these compression fractures of the lower end of the radius.

EXPLANATION OF FIGURES

- Figure 1: Normal lines of antero-posterior angle.
Figures 3, 4 and 5: Showing reversal and final results in cases of other surgeons and institutions.
Figure 3 and figure 5 were selected because of the excellency of these reductions in comparison with the usual, and because the X-ray men call such a reduction perfect.
Figure 4 was selected for the opposite reason. It is unusually bad as the others are unusually good, yet all are displaced.
Figures 2-10, 11, 13-15: Showing reversal in a few of our cases.
Figures 12-14, 16: Showing correction by our splint and lever.
Figure 9: Picture of splint and method of application.
Figure 6: Showing use of the lever.
Figure 7: Showing danger of anterior splint and mechanics of perpetuation of reversal.
Figure 8: Showing mechanics of correction and showing that when injured, as the posterior portion of the distal fragment turns downward and backward, the anterior portion turns downward and forward an equal distance, so that twice the apparent crush is necessary to completely restore the normal slant. This is accomplished in correction by the pressure of the carpal bones in flexion against the anterior-inferior portion of the distal fragment, forcing that portion backward and upward an equal distance as we turn the posterior portion forward and upward. This is assisted by the pressure of the small anterior splint pressing the inferior portion of the proximal fragment downward at the same time.

ARTROPLASTY OF THE ELBOW

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THE mobilization of an ankylosed elbow may be accomplished by simple excision, provided sufficient bone is removed, but such a procedure may render the part weak and unstable. To reconstruct a joint, with a wide range of motion and stability, which will stand the strain of average daily use, is a far more difficult problem. However, unless such a result can be secured a stiff joint in the most useful position is preferable.

In only selected cases should operative procedures for mobilization of an ankylosed joint be considered. The following pathological conditions, which are encountered, decrease the chances of success or actually contraindicate surgical measures:

1. Tuberculosis: In no case should a joint be entered for the purpose of mobilization when tuberculosis was the causative agent in the production of ankylosis. Undoubtedly, it might be possible to obtain excellent results in some instances, but the probability of "lighting up" a latent tubercular process is well known and should be sufficient warning against surgical measures.

2. In those in which a destructive osteitis, in early life, has obliterated the epiphyses a materially shortened extremity is encountered, mobilization of such a joint would not be of sufficient advantage to justify the means.

3. Extensive scar tissue, binding the skin to the bone, may obviously render the procedure unsuitable.

4. Extreme muscular atrophy with reorganization of bone structure, as is

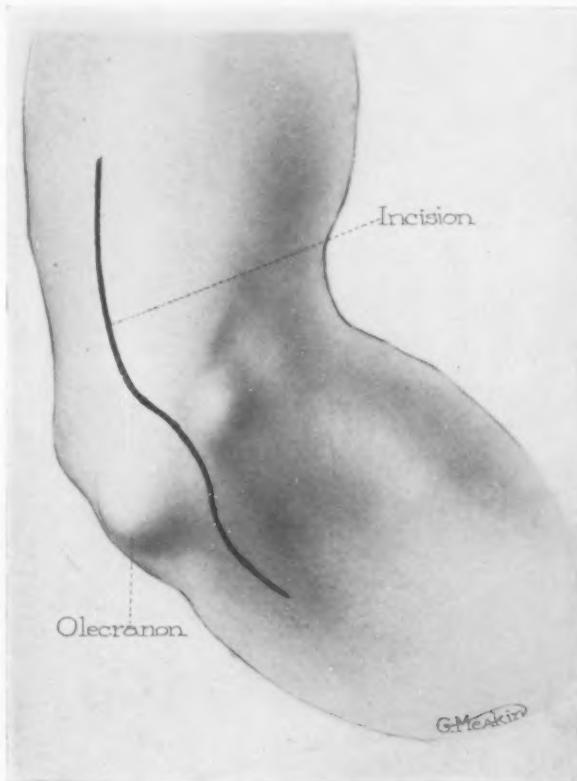


FIG. 1.—External lateral incision for approach to elbow.

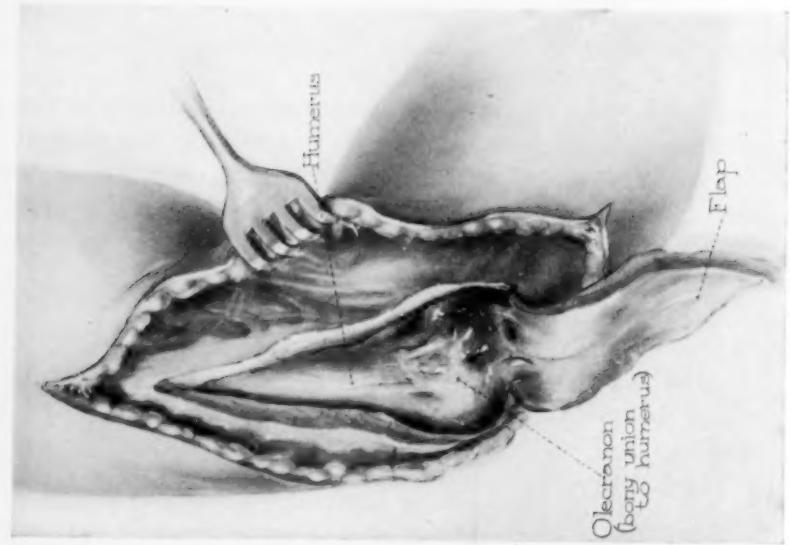


FIG. 3.—Fibers of the triceps muscle through which median incision is made and muscle retracted with peristom.

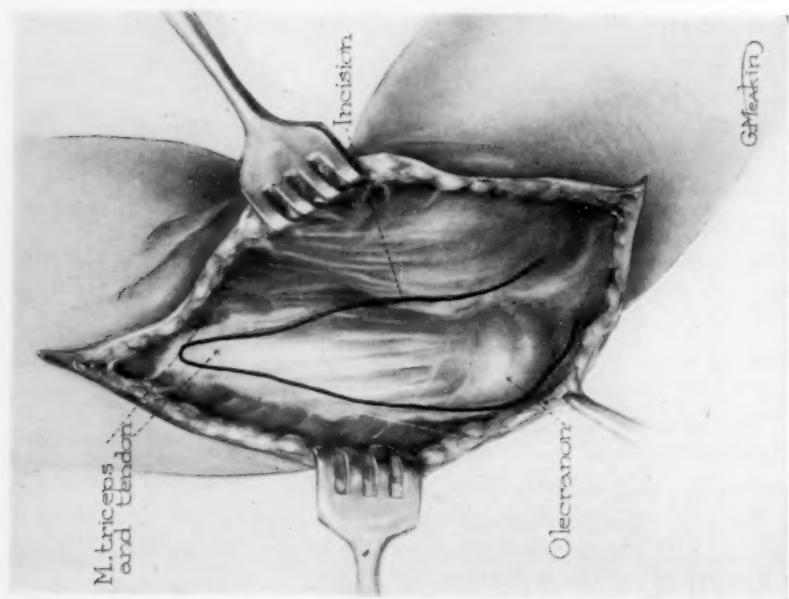


FIG. 2.—Dissection of aponeurotic flaps from posterior aspect of triceps.

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seen when a bony ankylosis has existed over a long period of time and the medulla of the humerus and ulna have become continuous through the joint, making one canal from the wrist to the shoulder. In such an instance, which is fortunately rare in the elbow, sufficient base would not be found to reconstruct a functional joint, besides the open medullary canal might be a factor to be considered. The muscular apparatus would also be extremely atrophic and its restoration difficult.

5. Old dense eburnated bone, when found for a considerable distance on both sides of the joint, is not favorable soil for reproduction of a movable joint. Such a condition is usually caused by an extensive virulent osteomyelitis, the result of which is a bone tissue of low grade, bearing the same relation to normal bone that scar tissue does to normal soft tissues. In fact, healthy, spongy bone should compose the articular surfaces of the new joint, consequently, the chance of success is very slight when the structure of the bone has been transformed for one or more inches beyond the joint line.

There are, in reality, only two conditions in which open surgical procedures should be employed in ankylosed joints for the purpose of restoring motion: First, traumatism, causing a crushing of the joint surfaces with tearing of the periosteum or multiple fractures, followed by bony ankylosis. Second, acute infectious arthritis due to staphylococcus, streptococcus, pneumococcus, gonococcus, etc. These organisms erode and disintegrate the cartilages and the superficial bone, unless the infection begins in the shaft and then we have an extensive osteomyelitis and not a localized arthritis.

In no case should this operation be lightly undertaken. The social status, occupation and co-operative intelligence, or "grit" of the patient, must be duly considered. For instance, a young woman applied for treatment with ankylosis of the elbow at about 160 degrees flexion, with the forearm in

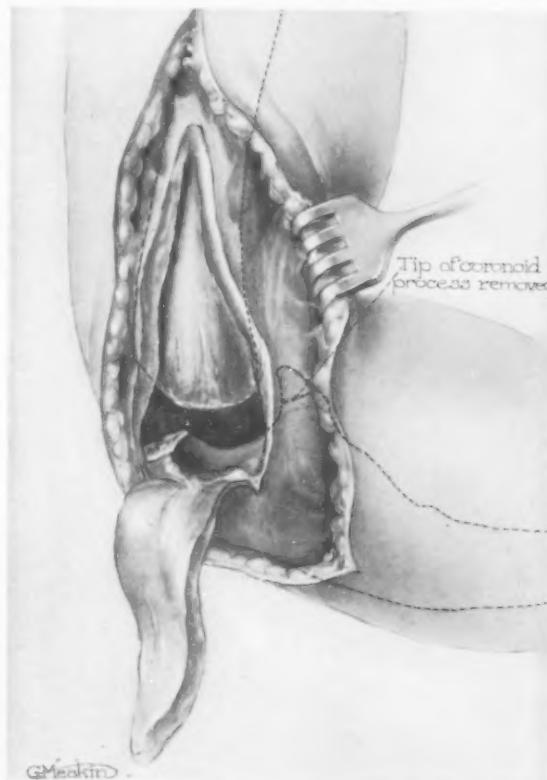


FIG. 4.—Remodeled articular surfaces.

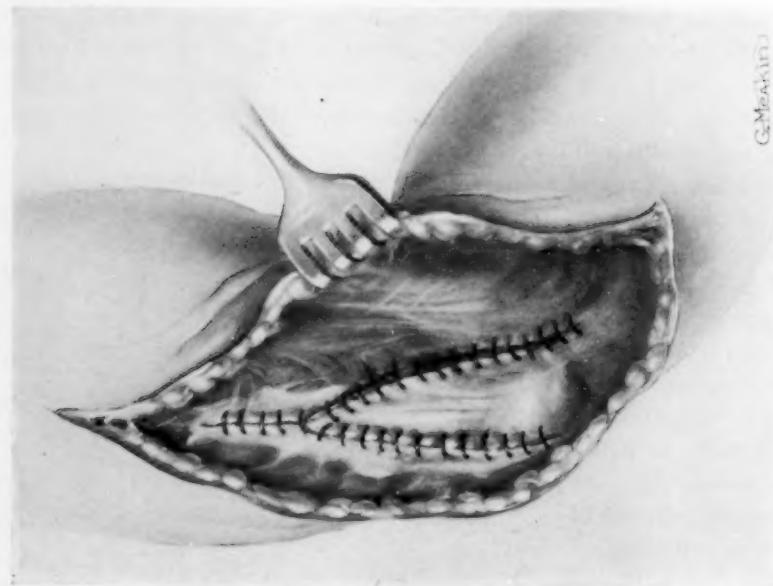


FIG. 6.—Closure of muscle and flap relaxing posterior structures which are often contracted.

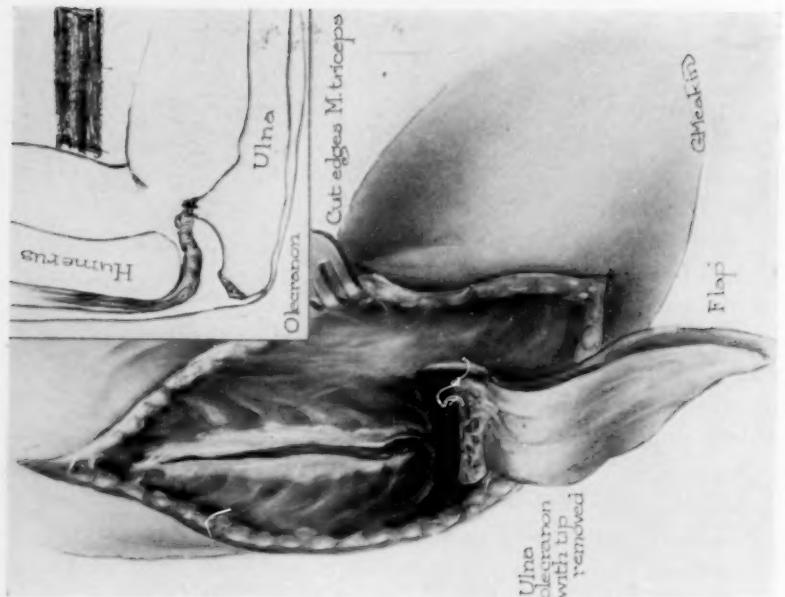


FIG. 5.—Closure of median incision through triceps, with living muscle interposition between joint surfaces, the redundant soft tissues being stitched to anterior capsule, when not available aponeurotic flap is used.

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pronation. She was a pianist and in her present state able to pursue her vocation. We declined to do the operation, though good function might have been secured, but, even if such was the case, we could hardly be sure of obtaining the required degree of pronation essential to successful performance on the piano.

A chronological survey of surgical procedures for the purpose of mobilization of joints with bony ankylosis has been omitted. However, there are five well-known methods practiced at the present time by various surgeons, as follows:

1. Wide excision of articular surfaces, which usually causes instability and should not be considered.

2. Pedunculated fascial flaps have been extensively employed between the articular surfaces, after remodeling or carving out a new joint. The procedure has been discarded by a majority of experienced operators in this field.

3. Interposition of animal membranes, specially prepared, such as *cargile* membrane, Baer's pig bladder, Allison's fascia, etc. While successes have been reported, the disadvantage is that foreign body irritation invites infection and the material is often excluded.

4. Transplantation of free fascia lata, extensively used by Putti, of Italy, and Russell MacAusland, of Boston.

5. Mechanical reconstruction of the articular surfaces with removal of sufficient bone to secure mobility without the interposition of any substance.

Recently we have employed a sixth method in elbows, which has been satisfactory in a limited number.

Our technic was evolved from our method for the reduction of old dislocations of the elbow, in which a posterior approach is used, the triceps aponeurosis dissected free, the muscle and the periosteum incised directly



FIG. 7.—Flexion six months after operation for bony ankylosis—arthroplasty.

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FIG. 8.—Extension six months after operation for bony ankylosis—arthroplasty.



FIG. 9.—Case II. Showing extension after hemi-arthroplasty.

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down to the bone in the midline, and stripped off en masse from the lower end of the humerus. This method gave such an excellent exposure of the elbow-joint and so little damage to those structures vital to the function of the joint, that it was decided to use it as the basis for our arthroplasty operation, the details of which are as follows:

An incision is made, from six to eight inches in length, on the posterior aspect of the arm and forearm, just external to the midline, beginning above, about the middle of the humerus and ending about two or three inches below



FIG. 10.—Case II. Showing flexion after hemi-arthroplasty.

the elbow-joint. Skin, superficial and deep fascia are incised without separation, the deep fascia is dissected laterally, about one inch. This brings the broad aponeurosis of the triceps into view. This structure is dissected from above downward, making a long tongue attached to the tip of the olecranon process below. A further incision in the midline passes through the muscular fibres of the triceps and periosteum to the humerus over the lower half. A periosteal elevator is now used to strip the periosteum from the lower third of the humerus. Scar tissue, callous and loose bony particles are removed. If dislocation exists, reduction is then accomplished without difficulty with periosteal elevator, scoop, or any blunt instrument.

There is no structure of consequence in the line of incision, no danger of vessel and nerve injury if one remains close to the bone; however, if ulnar nerve is exposed it can be isolated and anchored into a position of safety. About one-half to one inch is removed from the lower extremity of the humerus, which is remodeled into a surface convex from before backward, no attempt being made to reproduce trochlea or capitellum. About one-half

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inch of bone is removed from the tip of the olecranon process. All scar tissue is dissected from the sigmoid cavity. With a sharp chisel the surface is removed to healthy spongy bone. The radio-ulnar articulation is not disturbed, but the surface of the head of the radius must be made the same level as the coronoid process. A rasp and file render smooth all surfaces. The periosteum and triceps muscle are dissected into a double flap, which is stitched to the anterior capsule, thus separating the raw bony surfaces by a living mass of tissue with abundant blood supply and no risk of pressure necrosis. In those cases where the radio-humeral articulation is normal with bony ankylosis between ulna and humerus, the radio-humeral joint is not destroyed, but a hemi-arthroplasty is done between the humerus and the ulna. In such cases it is not always possible to obtain sufficient posterior flap in lieu of which the aponeurotic broad tongue from the triceps is placed between the surfaces. This structure is also employed when, for any reason, the posterior flap cannot be secured. The capsule of the joint is stitched to the posterior aspect of the triceps muscle and deep fascia, thus closing off the new joint, the wound is then closed in layers with catgut and dermal for the skin.

Full flexion and extension has been secured in one case with no motion in the radio-ulnar joint, but this is well compensated by rotation in elbow and shoulder. The procedure has been employed in a limited number of cases, but sufficient to warrant description in detail. To illustrate the essential facts, two cases are briefly narrated:

CASE I.—Girl, married, age nineteen, acute infectious arthritis of right elbow, six weeks' duration, was seen in consultation with Dr. G. C. Conyers, of this city, October, 1920. Joint at right angles with supination of forearm, acute tenderness and swelling, no hope of mobilization could be offered as X-ray showed complete destruction of articular cartilage, with atrophy and erosion of adjacent bone. No suggestions were offered except to continue splint as acute process was receding. July, 1921, eight months after cessation of acute symptoms, there was no swelling or tenderness, arm and forearm at right angles, no motion apparent. X-ray showed bony ankylosis. July, 1921, operative procedure, above described, was performed with primary union of wound. In three weeks gentle passive motion was given and active motion encouraged by a physiotherapist. This was continued for three weeks, when patient left the city contrary to our instructions, but returned September, 1921, when extension was complete with flexion to 60 degrees. Physiotherapy was again instituted to increase flexion, the result of which is shown in the illustrations.

CASE II.—Man, age fifty, February 3, 1921, sustained a comminuted fracture of the left olecranon and coronoid process, which was followed by solid bony ankylosis between the humerus and ulna. The radio-humeral articulation was free and movable, rotation of the forearm normal, position 90 degrees flexion. October 10, 1921, hemi-arthroplasty of the elbow as above described, interposing triceps aponeurosis; about 50 per cent. of normal motion was obtained within six months.

ARTHOPLASTY OF THE ELBOW

The after-treatment is very important and must be under the direction of the surgeon with coöperation of a competent physiotherapist. However, active motion is most essential, and can only be done through the voluntary efforts of the individual. In a few elbows and other joints I have seen excellent results by voluntary efforts of the patient, without the aid of anyone, except such instructions as could be given during an office visit, though the average patient will not make the effort without the constant attendance of the gymnast.

Operations for mobilization of joints or arthroplasties are far from 100 per cent. perfect, probably more successful in the elbow than elsewhere. Young adults give the best prognosis, but this is true of all operations. Our oldest case was fifty years of age. In no case has the member been more impaired; our only permanent sequela has been a recurrence of ankylosis, but with larger experience the proportion of success is greater each year, consequently, we believe that joints with ankylosis should be mobilized by operation when feasible.

THE DIAGNOSIS AND TREATMENT OF INCOMPLETE EPIPHYSEAL FRACTURES AT THE HIP*

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THE familiar chapter on fracture of the neck of the femur, which has been reproduced in the text-books without essential modification since the days of Sir Astley Cooper, is chiefly concerned with explanations of failure on other grounds than the obvious inadequacy of the treatment to provide the essentials of functional repair. From this standpoint the fracture has always been presented as practically an attribute of old age, induced by local atrophy, indicating faulty nutrition and therefore, the futility and danger of attempting to treat it on surgical principles. In other words, to quote from a leading treatise on fractures, "The ideal object of treatment, restoration of form and function, is rarely to be attempted or even sought."

As a matter of fact the neck of the femur is mechanically a weak point in the skeleton. The fracture is frequent in advanced life because the weak part participating in the general atrophy of old age is subjected to relatively greater strain because of inadequate muscular protection in locomotion.

Contrary to the general impression, however, the aged patients are far exceeded in numbers by those whose physical condition permits efficient treatment now made practicable by the abduction method, and from the therapeutic standpoint the most important cases are those in early life, a class, which has received as yet no adequate representation in the text-books.

Fracture of the neck of the femur during the developmental period may be divided into two distinct classes:

Fracture of the neck proper, and fracture at the epiphyseal junction.

In childhood the fracture is practically always of the neck. It is caused by direct violence, and is similar to the adult form except that it is more often incomplete, the neck having been forced downward and backward, leaving a wedge-shaped interval on the superior surface near the junction with the shaft.

Epiphyseal fracture is extremely uncommon at this age, because the junction is protected by a thick covering of cartilage which becomes progressively thinner as the area of ossification enlarges preparatory to final consolidation.

This fracture, or, as it is sometimes called, epiphyseal slipping, as compared with other fractures, stands in a class by itself. It occurs with rare exceptions only in adolescents.

* Read before the New York Surgical Society, May 10, 1922.

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It may be immediate and complete as the result of direct violence, but in most instances it is incomplete and presents the characteristics of a progressive deformity rather than those of fracture.

The patient may be in perfect physical condition, but in a certain proportion of the cases is fat and overgrown, presenting the indications of what is called endocrine disturbance, a constitutional predisposition usually present in bilateral cases.

It must be borne in mind, however, that weakness of this character predisposes to all static deformities and to epiphyseal displacement at the hip oftener than elsewhere only because the obliquity of the junction makes it more unstable.

The exciting cause of displacement is apparently a superficial fracture at the superior portion of the junction, or possibly a less direct injury which

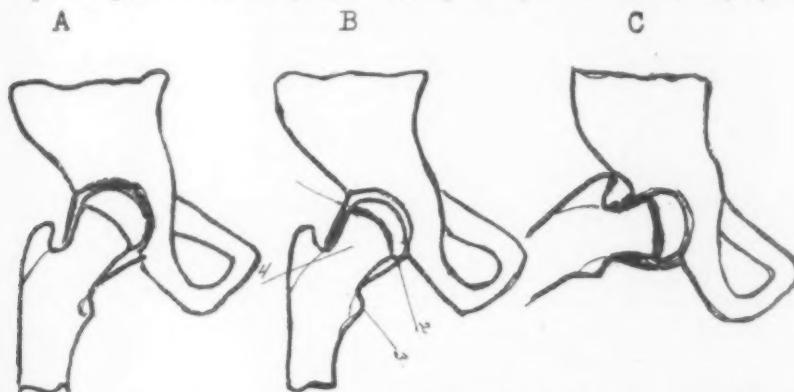


FIG. 1.—A. The normal joint. B. The changes observed in the X-ray picture in the early stage of epiphyseal displacement. 1. The upper border of the head and neck form an unbroken line in the same plane. 2. The lower border of the epiphysis projects downward in its relation to the neck. 3. The epiphysis appears shallower than the normal. 4. The neck appears, because of the outward rotation, shorter and thicker than the normal. C. Shows that in complete abduction pressure is removed from the epiphyseal junction.

weakens the immature bony structure on the diaphyseal side of the cartilage. Then follows gradual downward and backward displacement of the head upon the neck, the rate of progress being determined by the strain or injury to which the weakened tissues are subjected. Thus, under favorable conditions the process of repair may check further deformity, or the weakened junction may give way completely and the lame patient become suddenly disabled.

The clinical history and physical signs in a typical case are as follows: The patient, usually after injury which, however, may pass unnoticed, begins to limp, to complain of occasional stiffness and discomfort at the hip or knee on changing from rest to activity, and of pain after exertion.

These symptoms, usually passing as "rheumatism," persist and increase, often for months, even to the point of practical disability, before the patient comes under observation.

If any treatment is instituted it is usually for "hip disease," the pain, the limitation of motion, and the blurred outline about the cartilage in the X-ray

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picture seeming to establish such a diagnosis. Yet, to one familiar with this type of injury the diagnosis is almost self-evident.

The patient is an adolescent, and although he limps, the weight is borne on the entire foot rather than on the toes. There is persistent outward rotation of the limb, which is increased by flexing the thigh; actual shortening is present, but rarely exceeds half an inch; passive movements are restricted to a greater or less degree in flexion, abduction, and inward rotation, while extension, the movement first limited in disease, is actually increased in range.

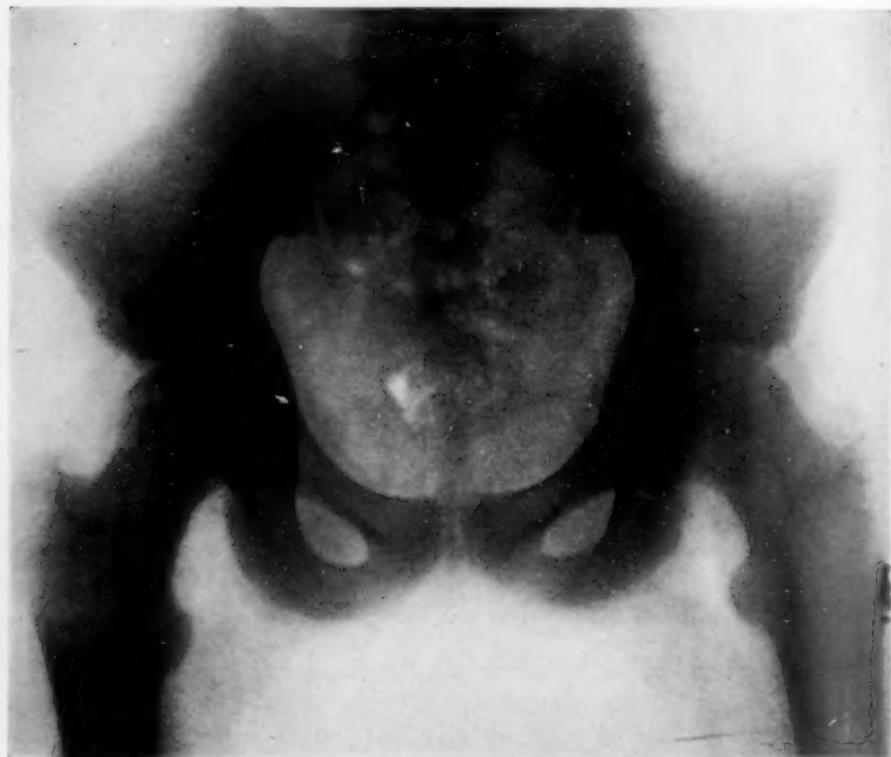


FIG. 2.—The changes indicated in Fig. 1 are shown in the X-ray picture of the left hip.

In other words, the muscular tension symptomatic of disease, checks all the movements of the joint in fairly equal degree, while in this form of injury they are mechanically accommodated to a head displaced downward and backward upon the neck. In the rapidly progressive stage of deformity, or of secondary fracture, there may be practical fixation by muscular spasm, but in such instances the history, and the attitude of the limb, should make the diagnosis clear.

The X-ray picture is distinctive. Under normal conditions the head rises sharply above the upper border of the neck; in these cases the elevation is lessened and the outline of the head and neck may form an unbroken line.

The epiphysis, as compared with its fellow, seems shallow, an indication of

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backward displacement; the epiphyseal junction seems wider, and an actual separation may be present at its upper border. (Fig. 1.)

The increase in width of the epiphyseal area is on the diaphyseal side and apparently indicates softened bone. This is sometimes discovered before the deformity is present, or at least apparent, and the subsequent displacement is attributed to local disease, but since this disease never progresses, and since it disappears after the correction of deformity, it seems more reasonable to ascribe the softening to injury which, although it may precede displacement, is usually coincident with it.

I shall introduce the subject of treatment with the statement that epiphyseal slipping, or epiphyseal coxa vara, or under whatever name it is classified, is, in the great majority, a form of fracture and should be treated as such.

Originally the cases of epiphyseal fracture that came under my observation were invariably of an advanced type, requiring an open operation for the correcting of deformity, as described in former papers. In more recent years, however, I have had the opportunity to treat a number of these patients under more favorable conditions. (Fig. 2.)



FIG. 3.—Epiphyseal displacement in a boy four years of age illustrating the progression of the deformity.

As has been stated, in typical cases the characteristics are those of a progressive deformity, the degree of which is indicated by the restriction of the range of motion. Thus, downward displacement of the head limits abduction, backward displacement limits flexion and inward rotation. Consequently restoration of the normal range in these directions implies the reduction of deformity. The primary indication for treatment, therefore, is to utilize the natural leverage, on which the abduction method is based, to overcome the restriction of motion. (Fig. 3.)

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Thus, under anaesthesia, the pelvis having been fixed by abduction of the sound limb, the limb on the injured side is abducted to the degree permitted by the deformity. At this point the upper rim of the acetabulum coming into contact with the neck serves as a fulcrum, and the head being fixed by the tense capsule, further abduction tends to force the extremity of the neck downward into proper relation with the head. (Fig. 4.) This may be accomplished if the progression of deformity has been rapid, or in cases of secondary fracture, although in two cases treated recently it was not until the third attempt that the restriction of the range of motion was overcome, indicating

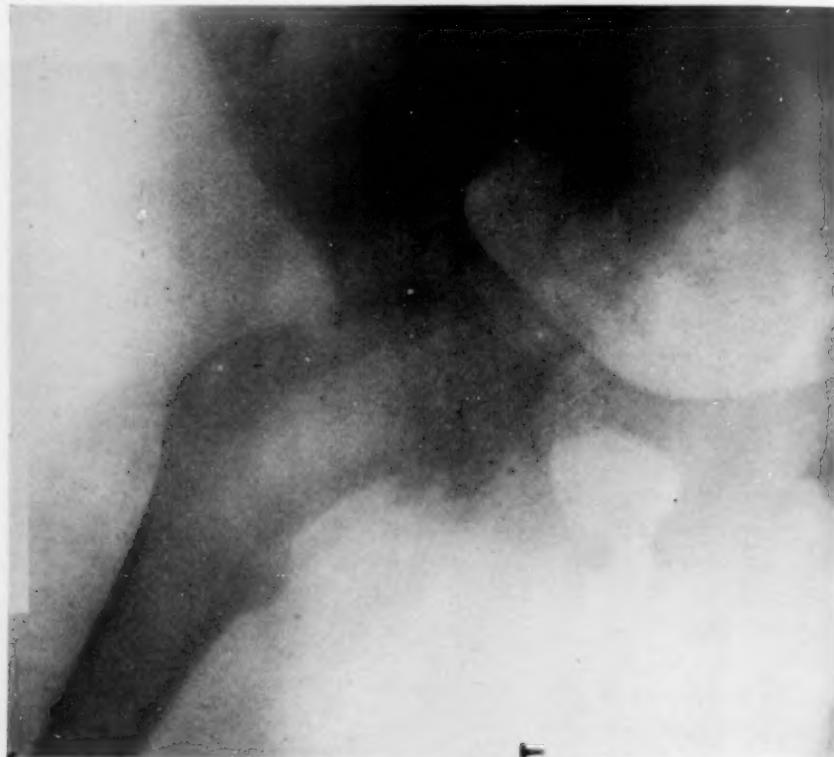


FIG. 4.—After reduction. Taken through the plaster spica. Contrast with Fig. 3.

the correction of deformity. In cases in which the displacement is too great, or the consolidation too advanced for correction by indirect force, open reduction will be necessary.

The joint is opened by an anterolateral incision exposing the neck, which, in cases of advanced deformity, practically conceals the head. From its extremity a thin section of bone is removed to permit the insertion of the chisel between the two fragments, then by rotation of the limb, and leverage on the instrument, the head is replaced in normal position.

The removal of bone is of little consequence since the epiphyseal cartilage is always a part of the head fragment.

Thus, from the therapeutic standpoint, these patients may be divided into three classes:

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First. Cases of slight deformity in which it is only necessary to fix the limb in the attitude of abduction for a time sufficient to permit repair.

Second. Cases in which the deformity may be corrected by forcible manipulation.

Third. Cases in which direct operation is necessary.

As has been stated, the restriction of abduction and inward rotation having been overcome, the limb is fixed by a long spica plaster in complete abduction, and inward rotation, for about three months, or for a period long enough to permit consolidation, during which locomotion may be permitted in suitable cases, since weight is supported by the trochanteric region of the femur. This is followed by exercises to restore muscular power and control, and naturally by general and special supervision and treatment, constitutional and local, as may be indicated. (Fig. 5.)

It must not be assumed that by indirect force an absolutely symmetrical relation between the head and neck is always restored. Nor is this, however desirable, essential to what is practically normal function, as is instanced by the irregularities of the head in congenital dislocation, in coxa plana, and by the various abnormalities of the components of the articulation, that are disclosed by X-ray examination which would otherwise have been unsuspected.

I might suggest in this connection that the removal of pressure from the head by fixing the limb in abduction should be utilized in the treatment of the so-called Legg-Perthes disease in which the influence of pressure tends to flatten the head, rather than to displace it. In such cases, if the pressure were completely relieved the progression of deformity might be checked. This is certainly desirable, for even though the characteristic distortion may cause but little disturbance of function, it may predispose to degenerative changes in later life.

What has been described as an epiphyseal fracture is now usually confused in orthopaedic literature with a group of static deformities under the title of coxa vara.

It seems to me in the interest of clearness of description that coxa vara should be restricted to depression of the neck of the femur as a whole in



FIG. 5.—Ambulation may be permitted in suitable cases of fracture of the neck of the femur in childhood because weight is born upon the outer border of the neck and trochanter. (See Fig. 1-C.) Figure reproduced from a former paper. (*Medical Record*, March 19, 1904.)

its relation to the shaft. In this sense, like genu varum and valgum, it is essentially a rhachitic deformity of early childhood, and like other so-called static deformities is characteristically bilateral, although not necessarily symmetrical on the two sides. In this typical form of coxa vara of childhood, the head is rarely depressed in its relation to the neck, in fact, the lessened angle tends, apparently, to establish a more horizontal relation at the epiphyseal junction which protects it from displacement. (Fig. 6.)

Bilateral coxa vara in adolescence is, in most instances, a further development of a preexisting deformity of childhood, a conclusion favored by the

history, and by the physical evidences of former rhachitis. In this class the more extreme degrees of coxa vara may be combined with deformity at the epiphyseal junction; constitutional weakness, mechanical predisposition, and the added strain of a relatively laborious occupation being the chief etiological factors.

Bilateral epiphyseal deformity distinct from coxa vara also occurs, constitutional predisposition of the endocrine type and injury being often combined as predisposing and exciting causes.

Since general weakness of structure should cause bilateral deformity, it follows that unilateral coxa vara in childhood, and unilateral epiphyseal displacement in adolescence, are in most instances the direct result of injury.

From the therapeutic standpoint the importance of a clear distinction between coxa vara and epiphyseal displacement is obvious, since in the first instance joint motion is mechanically restricted by a deformity which may be corrected by extra-articular osteotomy. Epiphyseal displacement by contrast disorganizes the joint, and it can be remedied only by intra-articular correction, either indirectly by leverage, or directly by open operation.

It may be noted that mixed types of deformity, usually bilateral, in which epiphyseal displacement is combined with coxa vara, have not been included in this exposition, because it has been my purpose to present a clear outline of a fracture of a peculiar type which is at present rarely recognized, and still more rarely efficiently treated.



FIG. 6.—Typical rhachitic coxa vara showing the relation of the head and neck as contrasted with epiphyseal fracture.

IMMEDIATE OPERATION AS THE METHOD OF CHOICE IN THE TREATMENT OF FRACTURE OF THE NECK OF THE FEMUR

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FRACTURES of the neck of the femur can, for practical purposes, be divided into two very broad groups: (1) those in which the principal plane of fracture is at the base of the neck and lies in close proximity to, or crosses, the intertrochanteric line (Fig. 1); and (2) those in which the principal plane of fracture lies proximal to this general area and lies for all, or its greater, part within the joint capsule (Fig. 2). When there is more than one plane of fracture it is generally found that the various paths along which the comminution takes place have a more or less single direction as determined by the resultant of the various components of the provocative force; the subsidiary lines of fracture arrange themselves in accordance thereto. Insofar as any individual fracture deviates from this definition, or combines certain characteristics of the other group in addition to those essentials of its own, the atypical features determine certain peculiarities in the clinical behavior of the fracture (Fig. 3).

Clinically the cases in group one are distinguished by their ability and readiness to heal under comparatively simple methods of treatment. This is undoubtedly due to the greater possibilities in the way of proper immobilization of the fracture and to the relatively greater blood supply of the area of injury. With this class of fracture there is practically never any difficulty in healing and the period of disability is comparatively short. In the cases in group two the possibilities in properly immobilizing the fracture are not nearly as good as in the other; the period of disability is comparatively much longer; the healing is often tedious and prolonged. The blood supply of the parts is relatively less abundant, and the intra-articular nature of the injury apparently furnishes some agent which interferes with bone production and facilitates bone absorption. All of these factors together explain the frequent failure of the conservative methods of treating the injury. The subsequent part of this communication refers entirely to this variety (group 2) of fracture of the neck of the femur.

In the conservative treatment of the latter class of fracture of the neck of the femur, one is confined essentially to (1) the use of the traction, or (2) to the immobilization of the fracture in plaster. There are a number of modifications of this method: that of Whitman, that of Mixter and that of Moore. Cotton's method of artificial impaction is, practically, a modification of the plaster method also.

The traction method is inefficient and produces the greatest numbers of the failures. Except in certain rare instances its use would not be justified with present-day knowledge.

The use of plaster is more satisfactory. All of the deficiencies of the traction method are either partly or wholly overcome by it. Necessarily its efficient use implies expert orthopaedic training and much practice; an adequate knowledge of the anatomical problems involved; the use of an orthopædic table; an anaesthetic; and the proper use of plaster. The abduction method (Whitman) of treating these fractures has been highly recommended.

At the present writing opinion seems to be divided between those who insist absolutely upon the universal applicability of the latter method and its uniformity of success, and those who, having tried the method thoroughly, are not quite so sanguine of success and admit a fair, if not a large, number of failures.

Between the two there seems to be no meeting ground; and the argument of the proponents of the method that the latter had not been properly applied by their antagonists does not seem acceptable in other competent circles. The truth of the matter seems to be that here again, as is so often the case in medicine and surgery, the difference is probably mainly one of nomenclature and depends upon the proper grouping of the fractures as defined in the opening paragraph of this communication; cases in the first group are endowed by their very position with an extreme readiness to heal and serve to explain much of the enthusiasm; cases in the second group are those which furnish the failures under conservative methods and provide the basis for any opposing opinion.



FIG. 1.—The following figures are taken from Cotton, Scudder and Stimson.

Redness to heal and serve to explain much of the enthusiasm; cases in the second group are those which furnish the failures under conservative methods and provide the basis for any opposing opinion.

No method of treatment seems applicable when the fracture, as it so often does, occurs in the old and decrepit individual. Here causes not under one's control—the danger of a hypostatic pulmonary congestion especially—force the surgeon's hands and compel a neglect of the fracture in the intense desire to obviate any complication which might cost the patient's life. One must make the best of a bad bargain under such conditions, and the patient must bear with as good a grace as is possible the pain and disability attending the persistence of an unhealed fracture of the neck of the femur.

At the opposite extreme are the fractures occurring in children. With very simple methods of treatment the fractures heal rapidly and excellent results are the rule. No thought of other than the most conservative forms of treatment is permissible.

FRACTURE OF THE NECK OF THE FEMUR

In between the two—between the old and the very young—are those fractures that occur in adolescence and early middle life, that is in full-grown, robust individuals. Fractures of the neck of the femur are not uncommon in this period and the frequency of the injury in the third and fourth decades of life has come to be well recognized. This is the group that is deserving of most thought. In men of the laboring class, in those who do any hard work, in those who must walk a great deal—salesmen, street-cleaners, policemen—the injury is a most disabling one; the length of time necessary for proper healing in the fortunate ones in whom healing does occur, is most excessive and can ill be spared by those who must earn their livelihood; in those who are not so fortunate and in whom non-union or mal-union occurs, the disability is practically a permanent one and the earning capacity of the individual becomes diminished to the extreme. Anything that will tend to diminish this disability is highly desirable.

In such people as well as in those of the more leisure class an unhealed fracture of the neck of the femur is further disabling because of the annoying pain. This follows walking of any extent, accrues in intensity and becomes practically continuous as the months grow into years, is extremely difficult to relieve by any apparatus, sours the sweetest of dispositions and frequently is sufficient to make life a burden. For those who are fond of the outdoors and are athletically inclined, it means a loss of all of these pleasures. For these, too, both rich and poor alike, anything that will give a restoration to the full capacities of life is highly desirable.

The time element in the healing of fractures of the neck of the femur is the most important. Excepting the children the time ranges from one year upwards. Usually one is so much absorbed in obtaining a bony union after fracture of the neck of the femur that the time element falls into obscurity and becomes a secondary and minor factor. Such a long time is, however, ill spared, or not sparable at all, by the daily worker and is rebelled against harshly and emphatically by his richer and more fortunate brother. Any method, therefore, that will shorten the period of disability is more than welcome for both poor and rich alike.

Up to the present time the results of the treatment of fracture of the neck of the femur—and I emphasize again that I refer to those described in group 2 of the opening paragraph of this communication—have been comparatively poor. In those insufficiently treated, or badly treated, it is

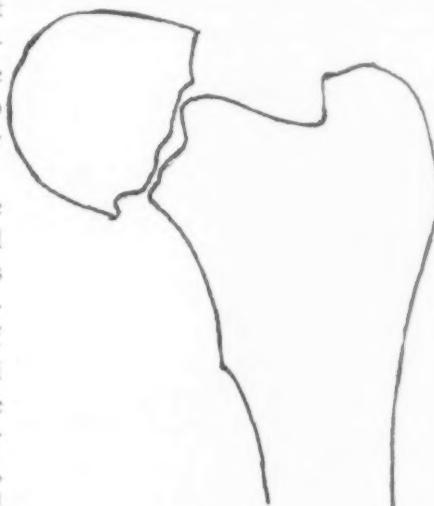


FIG. 2.

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more than probable that solid bony union does not occur in more than ten or fifteen per cent. of the cases and these probably include all of the impacted fractures. While the cases expertly treated by a few specially gifted men throughout the country undoubtedly show better results, I feel very sure that if the results of the work of a large number of average workers—after all that is the kind of result that counts in the long run—were analyzed, the results would be little better than the indicated ten to fifteen per cent. even when the best forms of conservative treatment were employed. This is rather a bad showing.

We are confronted, therefore, with a type of fracture which suffers from the following notoriously bad features: from being markedly disabling; from destroying completely the individual's earning capacity; from consuming a long and oftentimes unwarranted time in healing; from frequently leading

to distortions of anatomical structure of the femoral neck resulting in a diminution of function in the hip-joint and a crippling of the individual's activity even when bony union (mal-union?) is obtained; of commonly resulting in a failure to heal in which case permanent invalidism follows. Which method, conservative or other, in view of these discouraging features and factors, shall be considered best for men and women in adolescence or in the prime of life?

Shall it be the traction method? I have already referred to this method. Traction in the treatment of fracture of the neck of the femur had best be given up entirely. The method does not permit an accurate apposition and retention of the fragments and it yields the highest percentage of failures.

Shall it be the use of plaster and the abduction method? I quote from Whitman: "In spite of the development of the abduction method of treatment, we may assume that a certain proportion of transcervical fractures and fractures by decapitation (group 2 of our classification) will not unite. In determining this proportion we may range between the reports of Campbell, who obtained union in 85 per cent. of this type of fracture, and Delbet, who states that such fractures never unite under any form of treatment." Coming from this source the statement speaks volumes.

The average time necessary for the efficient healing of a fracture of the neck of the femur is, probably, considerably in excess of one year. A much longer period is no unusual time. For the average person this period is much too long to give up, especially if the method does not succeed in obtaining bony union. Shall one always be conservative, however, and give the plaster method a fair trial in every case before proceeding to any more radical measure? The probatory use of plaster and the abduction method under such circumstances would probably consume from three to four months with most surgeons and orthopedists and possibly much longer with a fair proportion of the remaining minority. If for any reason the method had to be abandoned,



FIG. 3.

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because of the lack of the evidences of any attempts at union, the elapsed time would be a total loss both economically and from every other standpoint.

Another important point with the use of plaster is found in the changes that the upper fragment undergoes in those cases in which healing does not occur. The head commonly becomes atrophic and thin and becomes incapable of bearing sufficient weight. In a large number the neck becomes partly absorbed and in many the absorption is complete. Then, too, shortening in the muscles and soft parts becomes fixed, and it becomes impossible to overcome it at any late period so that the shortening persists permanently. The ligaments of the joint also, become abnormally stretched and strained in various directions.

In such late cases operation becomes imperative. When operation is undertaken at this late stage the consummation of the attempt does not result in

a concomitant restoration of function at all proportionate to the degree of the bony union because of these changes.

An operation at this time, therefore, would be futile from this standpoint, whereas if it had been carried out successfully at those early times when the parts were in relatively normal anatomical condition, it would have yielded a femoral neck

of a normal contour and interior structure and it would have been followed by a proportionate return of function. A late operation causes a considerable loss of possibilities that would go with an early operation. Late operations, then, must be considered as makeshifts and one must not be surprised—rather, it ought to be expected—when incomplete results especially as regards function are obtained. I cannot illustrate this better than by the notes of the two following cases:

Hospital No. 147776. The patient fractured the neck of his femur two years before admission to the hospital by falling from a car. The man was forty-eight years old at the time of the injury but was otherwise a man of robust physique. He had been treated in the usual conservative manner at his local hospital in New Jersey by the application of a plaster hip spica which he wore for six months with no apparent benefit. At the time of my examination he complained of continued soreness in the hip while at rest and of much severe pain whenever he attempted to use the extremity, so that not only was he unable to continue his occupation as a bricklayer but he was also unable to walk any considerable distance beyond a few hundred yards before the pain compelled his stopping and resting. He wore no retentive apparatus. At this time the neck of the femur had been entirely



FIG. 4.—Taken after operation.

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absorbed as demonstrated in the X-ray pictures and the head of the bone was considerably atrophied. Motion was free in all directions. There was a moderate shortening of the affected extremity. He walked with a marked limp and was unable to rise unaided from a squatting position on the floor. The case seemed ideal from every standpoint for the bone pegging operation. He was quite eager to submit to any operation that promised relief.

I operated upon him according to the technic to be subsequently described and pegged the neck of the femur with a living graft taken from its shaft. The patient made an extremely satisfactory convalescence and the fracture healed apparently with bony union and a moderate amount of exuberant callus.

Two months after operation he walked about without any brace. Abduction never reached its normal. The limb was held in a relatively adducted position

as compared with the median line of the body. The shortening persisted. Because of these disadvantageous factors the patient still walked with a limp. He was, however, able to squat down on the ground and rise therefrom unaided, something which he had previously been unable to do. For a number of months he was free from pain; then some pain appeared at the site of operation and persisted. (Figs. 4 and 5.)

Hospital No. 190-494. This patient was fourteen years old at the time of his injury. In falling from a balcony he fractured the neck of his femur. Conservative measures were tried at first. The fracture was immobilized in abduction according to the Whitman method. The fracture seemed to be healing at first, according to the evidence shown by the röntgenograms, but, later, this opinion was shown to be incorrect; nevertheless we waited four months before operation was resorted to. It seemed inadvisable to wait any longer because the neck of the femur was beginning to show evidence of absorption and the head of the bone of atrophy. At this time motion was free in the hip-joint in all directions and was of normal extent; and there was an inconsequential shortening of less than one centimetre. The bone pegging operation was then done with the technic employed in the first case. (Figs. 6 and 7.)

This patient, too, made an uneventful recovery. The cast was allowed to remain for two months, after which an ambulatory splint was substituted and the patient was permitted to walk at first with crutches until he was accustomed to the brace, and then without them. The brace was worn for four months (six months since operation) and was thereafter discarded.



FIG. 5.—Final result, taken about five years after operation. Most of the bony union has taken place at the upper part of the plane of fracture immediately around the graft. Compare with Fig. 4.

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The final result is most excellent. Röntgenographically and clinically there is solid bony union between the parts. There is no coxa vara deformity. The graft has become thoroughly incorporated in the bony tissue of the femur so that it is indistinguishable; the region of the shaft from which the graft had been taken has filled up with normally appeared bony tissue. Indeed a comparison of both sides is necessary before the operated side can be distinguished and then careful scrutiny is essential.

The function results are equally good. The boy can walk and run and leap with the same facility that he could before the injury was sustained. There is full power in the limb. He has no pain even under violent exertion; The range of motion is normal in adduction and circumduction; it seems very slightly less than the normal side in flexion and abduction. The shortening is less than one centimetre.

These two cases give much food for thought. Shall immediate operative interference be regarded as the method of choice for the treatment of fracture of the neck of the femur in robust individuals? The cases demonstrate the possibilities

when the fracture has been pegged with a living graft at a reasonably early stage after the reception of the injury, and they show how these large possibilities are lost to a considerable extent when the fracture remains unhealed for an extraordinary length of time and the operation is done as a late measure.

In the old case the neck of the femur had been entirely absorbed. A shortening followed in the perpendicular diameter between the trochanter and head and the angle between the former normal line of the neck and the line of the shaft became diminished (coxa vara deformity). These defects were not, and could not, be corrected by late operation and, therefore, necessarily persisted thereafter. Whatever diminution of function resulted therefrom persisted similarly after operation. Following the operation there was bony union and good weight-bearing function; because of the impossibility of obtaining full abduction as was necessary the limp persisted. The latter was aided by the shortening of the extremity which had become firmly established in the long period since injury. The weight-bearing power, while sufficient for ordinary use, was not quite sufficient when active use of the limb was attempted, and shortly some pain appeared after excessive use. An incomplete result was, therefore, obtained as far as regards function.

In the fresh fracture union was rapidly obtained. The resulting union was not accompanied by any anatomical distortion, nor by any shortening of the



FIG. 6.—Taken within a few days after the injury.

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neck. The normal angle of neck to shaft also remained undisturbed. The normal range of adduction and abduction was retained in normal and equal proportion and was associated with normal function. No atrophy being present, weight-bearing was sufficient both in periods of comparative rest and in periods of active motion. A complete result was obtained in all directions.

In either case the length of time of confinement to bed and house was limited to a comparatively few months. Thereafter in the fresh fracture, even though the patient wore a retentive apparatus to guard the graft and the freshly healed fracture from any undue strain for a few months longer, the patient was enabled to go about with absolute comfort.



FIG. 7.—Taken about two and a half years after operation.

These experiences have led me to believe that this method of pegging the fracture with a living graft practised immediately after the injury is received is the method of choice for fracture of the neck of the femur in robust individuals. The great advantages of immediate operation include (1) an accurate apposition of the fragments, and (2) their permanent retention in that position until the fragments are united; (3) the use of a living graft to encourage and aid the formation of sufficient callus; (4) a marked diminution in the time necessary for complete healing of the fracture; (5) the consequent economic saving; (6) the better anatomical result including no loss of the neck angle, no shortening of the neck itself, no abnormal changes in the muscles, ligaments and soft parts generally; (7) the consequent better results obtained functionally.

There are no drawbacks to the use of the operative methods aside from the ordinary risks of operation, namely, hemorrhage, shock and infection. In the present state of our knowledge these dangers are entirely preventable and should not occur in any good hospital environment.

The use of a living graft is ideal for this purpose and is vastly superior to any metallic, beef bone or other artificial means of fixation and support. This opinion, in the present state of our knowledge, seems incontrovertible and is acceptable as correct in the best circles.

The following is essentially the technic which I have employed:

I recommend that operation be done within a few days after the injury is received. The patient is properly prepared and is put on an orthopaedic table (I prefer the Hawley table). The injured extremity is pulled down until there is slight overcorrection of any shortening; the limb is abducted widely. Any

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sagging of the trochanter on the injured side is corrected by an assistant's hand or by a band supported from the overhanging upright. The opposite extremity is put in similar position. With the aid of palpation and the X-ray pictures the trochanter, the head and neck—in fact, the whole upper extremity—of the femur are outlined indelibly on the skin; with a little practise this can be very accurately done. Thereafter the skin is sterilized and the parts are appropriately draped with sterile sheets, etc. (Fig. 18).

A sufficiently long (6 to 8 inches) incision is made on the outer aspect of the hip and thigh extending from about two inches above the tip of the trochanter downwards; the fascia femoris is similarly divided; the muscles are separated bluntly and the upper segment of the femur and the trochanter major are exposed to adequate view by retraction of the soft parts. Bluntly with the finger the muscle planes are separated and raised from the underlying skeleton until the capsule is reached and, always, it is easy to reach the area of fracture and to palpate this through the capsule which need not be necessarily opened. I have not found it necessary to make any second incision in front directly over the joint. With the aid of the finger in the wound and with the outlines of the parts on the skin as guides, a hand drill is applied at the base of the trochanter and a hole is drilled up into the neck and head of the bone and lying in their centre as far as seems necessary from the X-ray pictures; the latter distance is accurately measured previously on the röntgenograms and is used as a guide in drilling. I use a hand drill—the Hudson drill—with the cerebellar attachment and appropriate burrs have served me very well. I prefer hand instruments to motor-driven ones, but there is no objection to the latter type if so desired by the individual operator.

As soon as one is sure that the drill hole is sufficiently long, the drill point is disconnected from the main part of the instrument and is allowed to remain *in situ* as a temporary support until the graft is ready for insertion.

The graft is taken from the outer aspect of the shaft of the femur lying in the wound and extending from a short distance below the base of the

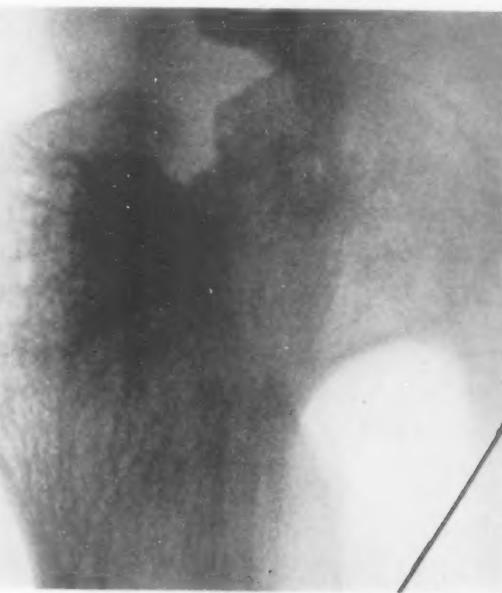


FIG. 8.—Taken about two months after operation.

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trochanter downwards. Again I use hand instruments—chisel and mallet. The graft to be removed is accurately outlined beforehand. The graft includes periosteum and the entire thickness of the cortex, together with a generous layer of cancellous tissue and the endosteum; it reaches into the marrow cavity. The graft is so cut as to fit loosely in the drill hole, extending into the neck and head of the femur. I believe this has advantages: (1) it is easy to introduce; (2) it allows a certain amount of drainage around itself; (3) no pressure necrosis will occur and no sequestra ought to form; (4) it will be easier for the graft to find adequate nourishment; (5) a small amount of blood will collect in the drill hole around the graft and will encourage callus formation; (6) a large graft is permissible.

As soon as the graft is ready, the drill point is withdrawn and the graft is quickly inserted in its place; it should not project beyond the trochanter surface. The wound is then ready for closing. I have not found it necessary to do anything to the bed of the graft in the femur nor to secure the graft in its new bed by any suturing; the closure of the soft parts accomplishes this accurately. The muscles, fascia and skin are approximated individually with interrupted sutures of catgut. No drainage of any kind is necessary.

During all of this time the patient has been securely held on the table in the proper position for the application of the necessary immobilizing cast. All one does now is to drop the foot of the Hawley table and the patient is ready for the cast. It is not necessary to include the lower part of the leg or foot, but it is necessary to include the upper half of the leg, the knee, the entire thigh, the hip and the pelvis and abdomen as far as the lower thorax. This will give adequate immobilization of the hip.

It is possible to do the entire operation within thirty minutes. This is a relatively short operative time. The degree of shock is at a minimum and is easily withstood by any patient even if in only fair condition. The reaction is usually of a very minor character.

The cast is left undisturbed for two months. At the end of that time it is removed and an ambulatory splint is prepared. Meanwhile the parts are massaged and the joints all gently moved every day until a fair amount of power and range of motion returns. At the end of the third month the patient is gotten out of bed and permitted to walk with the aid of the ambulatory splint, at first with crutches also, but within a few days without them. Within a short time the patient accustoms himself to the apparatus and can get about very well indeed. At the end of six months it is safe to discard the brace entirely.

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SPRAINS OF THE RHOMBOIDEUS MINOR MUSCLE

A STUDY OF ONE HUNDRED AND FIFTY INJURIES OF THE SHOULDER GIRDLE

BY JOSEPH P. REPLOGLE, M.D.

OF JOHNSTOWN, PA.

SURGEON TO THE CAMBRIA STEEL COMPANY

BECAUSE of its peculiar anatomical make-up, a freely movable ball-and-socket joint capable of performing a greater variety of movements than any other joint of the body, held in place not by strong ligamentary attachments, but deriving its security to the trunk mainly through its muscular coverings, the shoulder joint is probably more susceptible to traumatic lesions than any other joint of the body. At the same time text-books have practically nothing to say in regard to the physical position of muscles in relation to their mechanical effect when a joint is put out of gear by some lesion of the shoulder or its immediate neighborhood. The ligaments have comparatively little clinical importance. The muscular and fibrous planes, bursæ, and nerves are, therefore, exposed to manifold injuries either from over-stretching or direct blows. There is no joint so likely to provide traps for the unwary surgeon, and a patient who cannot raise his arm high enough to fasten his collar or brush his hair remembers his surgeon daily and not with thankfulness if he feels his injury has suffered neglect.

How often have we diagnosed a "sprain of the shoulder" merely to satisfy a patient's anxiety concerning his injury, for he then puts at rest his fear and feels that it will soon get well with poulticing, rubbing, or the application of a patent liniment?

And how seldom is an attempt made to diagnose a sprain with some degree of localization of the structures involved, with the idea of applying appropriate treatment so as to rest or "splint" that particular overstretched muscle or ligament? The term "sprain" applied to the shoulder means no more than the term "peritonitis" applied to an abdomen, and the treatment

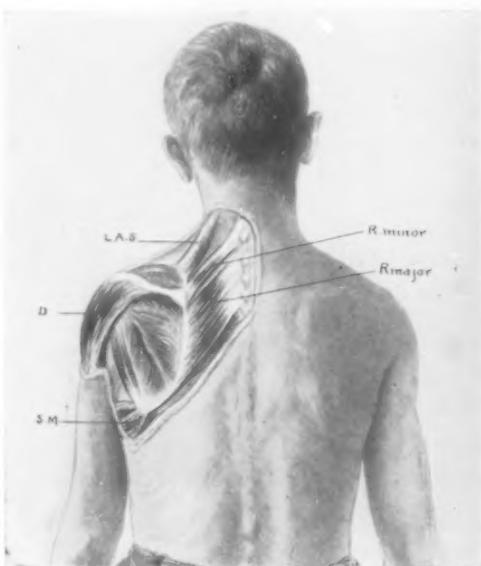


FIG. 1.—Dissection showing normal position of interscapular muscles—the skin, trapezius and latissimus dorsi having been removed. Note almost horizontal position of spine of scapula, also origin and insertion of rhomboideus minor muscle where tenderness is found.

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of a "sprain" of the shoulder as does "peritonitis" of the abdomen demands measures appropriate for that individual type of pathology.

The literature describes the classical acute lesion of the shoulder girdle sufficient to require emergency treatment, such as dislocation or fracture, but excepting description of subdeltoid bursitis we read very little of the patient who presents himself a day or two after the accident on account of pain or disability, or else seeks advice in a week or two because improvement under home remedies has been so slow that he fears the injury is more serious than he at first supposed. An analysis of one hundred and fifty successive cases of shoulder injuries observed at Cambria Steel Company hospital, excluding

burns and very minor injuries, revealed twenty-six varieties of lesions in and about the shoulder. As would be expected, severe contusions with accompanying temporary palsy or periostitis of superficial bony prominences, such as the acromion process or spine of the scapula, make up thirty per cent. of the lesions. About twenty-five per cent. of the lesions are sprains of various individual muscles or muscle groups. Dislocations and fractures make up eighteen per cent., while only six per cent. are diagnosed subacromial bursitis.

Twenty-five per cent., therefore, of our lesions are sprains, and excluding severe contusions

it is very surprising to know that in our series one lesion which I have termed sprain of the rhomboideus minor muscle is more frequent than any other traumatic lesion of the shoulder.

Because of its frequency of occurrence and its remarkably constant symptomatology, a description of this particular sprain might not be amiss.

It occurs usually in those performing heavy or strenuous labor such as swinging a sledge, firing a furnace, or the sudden lifting of a heavy weight. At the time of the sprain he feels a sudden knife-like, sticking, or stabbing pain just median to the base of the spine of the scapula. Occasionally he tells us it felt as though he pulled a leader. Pain bothers him for fifteen to twenty minutes, but he usually resumes work and finishes out the day. That night he notices aching between the shoulder blades and disability begins the following day when pain and aching accompany use of his arm.

An examination reveals a very definitely localized point of tenderness



FIG. 2.—Showing normal position of scapula and rhomboid muscles.

SPRAINS OF THE RHOMBOIDEUS MINOR MUSCLE

about the size of a quarter just internal to the base of the spine of the scapula. He can abduct his arm to about 90° (Fig. 3) at which point he suddenly feels aching pain referred to the point of tenderness. Further elevation of the arm aggravates the pain, which is worse when the arm is fully abducted and passed anteriorly over the chest so that the hand rests upon the opposite shoulder with the elbow at height of the brow. Aching between the shoulder blades at night is a common symptom. With the head rotated to the side of the injury, if we tilt it on its axis to the opposite side, he will complain of pain referred to his point of tenderness. Standing with the body erect and shoulders thrown back is the most comfortable position for him.

In order to explain the symptomatology it is well to review the muscular action in raising the arm. Abduction is mainly produced by the interaction of the deltoid, trapezius, and the serratus magnus. (See Fig. 1.) The serratus magnus arising from its nine or ten fleshy digitations from the upper eight or nine ribs and passing backward to be inserted along the vertebral border of the scapula, serves to keep the scapula closely applied to the thoracic wall and draws it laterally. Since the portion inserted into the inferior angle is the strongest, a fulcrum action is produced and the scapula rotates, raising the lateral angle. By this action the serratus plays an important part in abduction of the arm, since, in the first place, by fixing the scapula it allows the deltoid to expend its action on the humerus, and, in the second place, after the deltoid has completed its action and has raised the arm through about 90° , further elevation through another 90° is accomplished by rotation of the scapula resulting from the combined fulcrum action of the serratus and the trapezius. It is by this muscular combination that the interscapular muscles—the rhomboideus minor and major and levator anguli scapulæ—are overstretched.

To offset the strong muscular force of the serratus, deltoid, and trapezius combined, we have a much weaker counter-action produced by the inter-



FIG. 3.—Arm at 90° from chest wall, normal position of scapula and rhomboideus shown by white dotted line. Black dotted line shows change in position with arm abducted to 90° , shaded area showing increase in length of rhomboideus. Pain is first experienced at this degree of abduction.

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scapular muscles—the rhomboideus major and minor and levator anguli scapulae—plus the force of gravity due to the weight of the arm.

It is not unusual then, that a sudden contraction of the trapezius, deltoid and serratus would overstretch this weaker interscapular group. The rhomboideus major having a wide origin from the spinous processes of the four upper thoracic vertebrae and intervening interspinous ligaments and a wide insertion into two-thirds of the vertebral border of the scapula and being stretched the least, suffers the least, while the band-like rhomboideus minor, arising from the spine of the sixth cervical vertebra and inserting into the vertebral border of the scapula at the base of the spine of the scapula, with more obliquity to its fibres is overstretched more, with a resulting avulsion of fibres at its insertion into the spine of the scapula where the tenderness is found.



FIG. 4.—Arm fully abducted, showing further increase in length of rhomboideus from 90° to full abduction indicated by solid black area. Cross shading indicates position of muscle in Figure 3 and plain shading the normal length of interscapular muscles.

depress the base of the spine of the scapula, producing tension on rhomboid muscles.

Occasionally we find slight pain and tenderness near the spinous process of the last cervical vertebra at the origin of the rhomboideus minor, and in thirty per cent. of the cases there was slight tenderness along the vertebral border of the scapula below the spine in the region of the rhomboideus major.

We would deduce, then, that any muscular movement producing elevation of the lateral angle of the scapula, especially when occurring suddenly, overstretches the interscapular muscles and gives potential etiology for sprain of the rhomboideus minor.

The treatment is based on anatomic lines to cause relaxation of the overstretched muscle. The shoulders are thrown back so as to lessen the interscapular space and criss-cross adhesive straps are applied maintaining

SPRAINS OF THE RHOMBOIDEUS MINOR MUSCLE

this position. The arm is placed in a sling and a small pad placed under the adhesive over the point of tenderness to possibly hasten the absorption of the serous effusion at the point of rupture or strain.

The above treatment gives immediate relief from aching, and pain on abduction is greatly reduced. We have several times removed the cross strapping too early and patients have requested its reapplication to obtain relief.

Because of the frequency of occurrence of sprain of the rhomboideus minor, the unusual constant symptomatology and clinical picture, the efficacy of simple and proper treatment, together with the fact that it is of sufficient seriousness to cause industrial disability, justify a description and demand cautiousness for diagnosis of this lesion.

TRANSACTIONS
OF THE
PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting Held April 3, 1922

The President, DR. JOHN H. JOPSON, in the Chair

TETANUS FOLLOWING HERNIOTOMY

DR. GEORGE P. MULLER reported the following case:

A man, aged thirty-seven, was operated on for a recurrent inguinal hernia. Chromic catgut used throughout. Rubber dam drainage in the fat for twenty-four hours. Patient had scratch marks on the abdomen from shaving during preparation and had cut himself on the face on the day before operation. No other etiological factors. Eight days after operation he complained of soreness in the region of the wound and two days later trismus was noted. Death occurred eleven days after operation. Patient treated by intravenous and spinal tetanus anti-toxin. Wound contained no tetanus organisms.

PROLONGED WELL-BEING IN CASE OF INOPERABLE CARCINOMA OF SIGMOID COLON TREATED BY COLOSTOMY

DR. GEORGE P. MULLER presented a man, sixty-two years of age, who was admitted to the Misericordia Hospital, August 18, 1920, complaining of "cramps" when the bowels moved; some blood in stools, loss of 20 pounds in weight. At operation (August 21) a mass was found in the sigmoid flexure of rather large extent and almost completely occluding the bowel. Many small nodules were scattered under the pelvic peritoneum. Six or seven nodules the size of grapes were found in the liver. As the case was deemed inoperable from the radical standpoint, an inguinal colostomy only was performed.

The patient did well. A Wassermann test was pronounced negative. Three months later he had gained 5 pounds and nineteen months later he had gained 13 pounds since the operation. He sleeps well, eats well, has no pain, and the bowels move every day between 9 and 12 A.M., through the colostomy bag. They move suddenly as though propelled by a peristaltic movement. Practically no discharge comes from the anus.

Comment.—This case well illustrates the advantage to be obtained by conservative treatment of an advanced carcinoma of the lower colon, and the formation of a colostomy before acute obstruction occurs. Cripps in 1912 reported upon his results in colostomy as showing a mortality of 40 per cent. in twenty-four cases when the operation was done in the presence of obstruction, whereas of forty-four cases oper-



FIG. 1.—Lower tray.

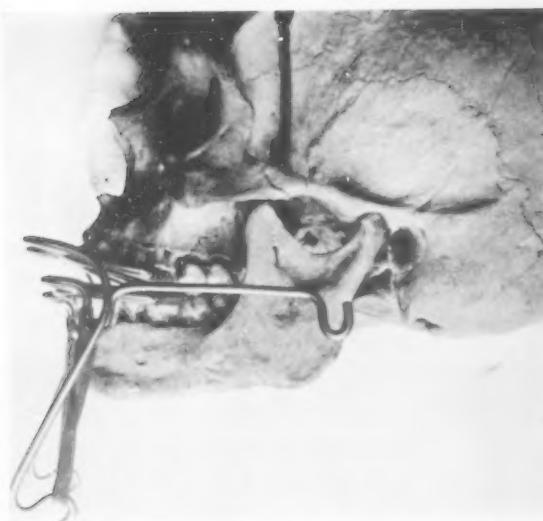


FIG. 2.—Appliance mounted on skull, lateral view.



FIG. 3.—Appliance mounted on skull, anterior view.

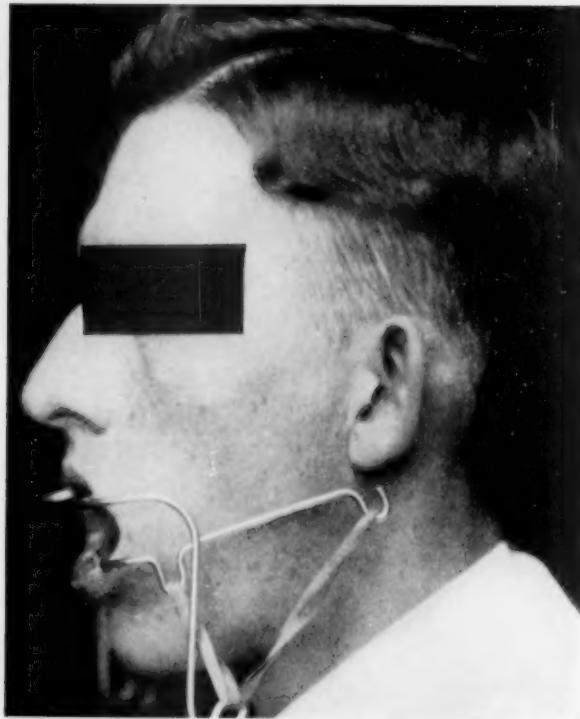


FIG. 4.—Appliance inserted in mouth, lateral view.

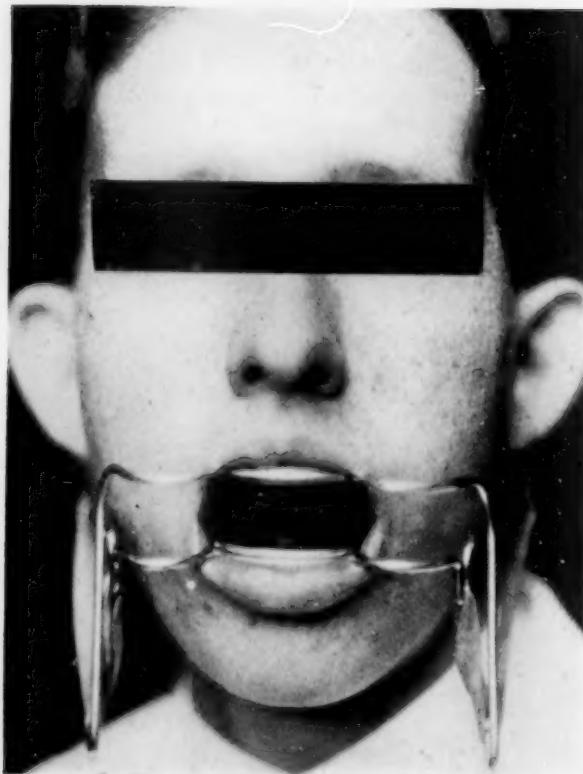


FIG. 5.—Appliance inserted in mouth, anterior view.

TREATMENT OF MANDIBULAR ANKYLOSIS

ated on before acute obstruction developed there were no deaths. Paul in the same year reported twenty-one cases with obstruction and approximately a 50 per cent. mortality, and 125 cases without obstruction with a mortality of only 4 per cent. In regard to longevity Paul noted that the cases having colostomy lived an average of twenty-two months, whereas those patients of inoperable cancer left alone only lived an average of seven and eight-tenths months.

UNIVERSAL JAW DILATOR AS AN ADJUNCT IN THE TREATMENT OF MANDIBULAR ANKYLOSIS

DR. ROBERT H. Ivy said that to insure permanent success in the treatment of any form of chronic limitation of motion of the mandible, whatever operative procedure is performed it should be supplemented by mechanical stretching apart of the upper and lower teeth. In mild cases, such as frequently follow acute inflammatory conditions involving the muscles of mastication or fracture in the region of the angle, mechanical treatment alone may suffice to bring about free motion, without resort to operation. Many forms of apparatus, from the spring-clip clothes pin and the rubber cork inserted between the teeth to the most complicated devices, have been used for this purpose. It is recognized that a constantly acting mild force, either by springs or rubber elastic, will accomplish better results with less danger of injury than sudden positive application of screw pressure acting powerfully for brief periods at repeated intervals. Heretofore, it has generally been necessary to first obtain impressions of the teeth prior to the construction of an apparatus suitable for the individual case. This frequently occasions a delay of several days before insertion of the appliance, during which recontracture of the jaws occurs. In the jaw dilator here presented, it is believed that these objections have been overcome, as it can be made as a stock appliance, in three sizes, ready for immediate use either after operation or in other cases where there is an initial opening between the teeth of one centimetre. It can be easily fitted by the surgeon, and is practically as stable as an apparatus that has been made from dental impressions of the individual. The construction is extremely simple, the two parts being flat metal trays passing between the occlusal surfaces of the upper and lower teeth. The trays can be inserted through a space of less than one centimetre between the upper and lower incisor teeth, which is manifestly insufficient space to obtain impressions. To the outer sides of each tray are soldered heavy wires which pass out of the mouth and curve backward over the cheeks in the manner of Kingsley splints. The wire attached to the upper tray on each side turns down at a right angle about opposite the premolar region and ends in a hook about three inches lower down. The wire attached to the lower tray passes directly backward horizontally and is provided with a hook at a point opposite the downward turn of the upper wire. The dilating force is a heavy elastic band placed between these hooks on each side. This application of dilating force in the manner described is original with Darcissac of Paris (*Dental Cosmos*, March, 1922), who has proved its value in numerous cases. Darcissac, however,

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made individual apparatus from impressions of each case, casting metal caps to fit the teeth. The advantage claimed for the present appliance is that it is ready for immediate use in any case with not less than one centimetre of separation, without the necessity of impression taking. It can be applied readily without any special skill, and can be used much earlier in the case when there may be insufficient room for taking impressions of the teeth. The elastics produce a constant counteraction to the powerful elevator muscles of the mandible, which at the same time are permitted to function, the upper and lower jaws being at no time fixed. Lateral movements as well as opening and closing are possible. Where additional stability is desirable the trays may be filled with a little softened dental impression compound before insertion, to receive the imprint of the teeth. This compound can be renewed from time to time. The dilating force can be readily regulated by the size and tension of the elastic bands. In some cases, where it is advisable to aid in the forward movement of the condyle as the mouth opens, this can be accomplished by running a second rubber band between the hook on the wire attached to the upper tray and one placed at the extreme posterior end of the lower wire.

He was indebted to Mr. J. A. Eberly, Jr., of the Senior Class of the University of Pennsylvania School of Dentistry, for following his suggestions in the construction of the original models of this appliance; also to Messrs. George P. Pilling and Son Company, Philadelphia, for making the finished appliance.

Stated Meeting Held May 8, 1922

The President, DR. JOHN H. JOPSON, in the Chair

BRANCHIAL FISTULA

DR. BENJAMIN LIPSHUTZ presented a girl, six years of age, in whom, after an attack of scarlet fever two years ago, there appeared a small opening surrounded by an inflammatory areola and discharging pus, situated at the anterior border of the right sternomastoid muscle between the angle of the mandible and the inner end of the clavicle. Pressure over the latter caused the exit of distinct pus. On examination a distinct cord was felt which seemed loosely attached to the surrounding and subjacent structures and over which the skin moved freely. Colored fluid injected through it came out of the mouth. No probing of the tract was attempted because of the infection present, and because it is frequently impossible beforehand to know the type of fistula under consideration.

Operation at the Mt. Sinai Hospital, March 4, 1922, ether anaesthesia. An incision was made so as to leave a small disc of skin about the margin of the opening and extended upward and backward nearly to the angle of the jaw. On cutting through the skin, fascia, and platysma the sinus was exposed to view. It lay on the deep fascia

EXOPHTHALMIC GOITRE

parallel to the sternohyoid muscle and was unexpectedly clear. It was rather easily separated from the surrounding structures, except its posterior surface, which was adherent to the carotid sheath, especially the internal jugular vein. Continuing the dissection, the entire fistulous tract was dissected upward to the digastric muscle, and separated without injury from its attachment to the pharyngeal muscle. The presence of the infection did not permit the inversion of the fistula into the mouth, as first advised by V. Hacker in 1897. The latter procedure can only be successfully carried out when the fistula is freely movable and has a lax attachment to the surrounding structures. Hacker, Whitacre, Helferich, and Dowd have reported cases in which the latter procedure was successfully performed. At times the excessive amount of fibrous tissue, muscle, etc., in the wall of the tract prohibits the inversion of the fistulous tract. In some of the fistulae it is impossible to dissect them away without destroying important next structures, a procedure which the primary condition does not justify. A mouth-gag was then placed in the mouth and the blunt end of a probe was passed upward from the upper end of the operative wound in the neck to the floor of the mouth, to the anterior inferior border of the right tonsil. A small incision was made in the oral mucous membrane over the probe. The distal end of the fistula was tied to the open end of the probe with silk and the probe drawn into the mouth, the fistulous tract following until it seemed to be on a stretch. The distal portion of the fistulous tract was removed and the portion remaining was fixed to the mucous membrane of the mouth by two chromic catgut sutures, as advised by Konig. The fistula now has both openings in mucous membrane, the inner end in Rosenmuller's fossa, the other in front of the tonsil instead of in the skin. There is thus produced an open canal beneath the oral mucous membrane in which retention cannot take place.

EXOPHTHALMIC GOITRE

DR. CHARLES F. NASSAU presented a woman, forty-nine years of age, who first noticed thyroid pressure symptoms about fifteen years ago. From that time the swelling gradually increased in size. Three years ago she began to suffer from dyspnea and symptoms became progressively worse. For the past two years she has had the oncoming of the symptoms of hyperthyroidism, everything except exophthalmos. One year ago she was in bed three months with dilatation of the heart. For the past year she has been having X-ray treatment, having in the past refused operation. Admitted to the Mt. Sinai Hospital in a terrible condition; seemed asphyxiated and about to die. On April 11, 1922, Doctor Lipshutz made a straight incision in the median line and divided the isthmus. Since then it was determined that she also had substernal goitre, probably bilateral. Heart feeble and pulse too rapid to count. On May 8 her heart-sounds were fairly good, pulse 90 to 100. Patient not able to lie down, had to be operated on partly sitting up. Operation under local anaesthesia morphine. Goitre ex-

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tremely difficult to get owing to the fibrous development from X-ray. Patient was now entirely relieved of all cough, not nervous, pulse-rate down and quite comfortable.

DOCTOR NASSAU presented also a man, thirty-three years of age, who one year ago noticed enlargement of the neck. He had palpitation of the heart and shortness of breath. On admission had exophthalmos, etc. Pulse 80 to 140, had difficulty in keeping patient in bed; almost continual vomiting. He was kept two weeks in bed before operation with ice-bags and oxygen inhalations. Ligation of one side was done in his room. The reaction was very great for seven days, when the second ligation was done. Patient was discharged to come back. On his return, under local anaesthesia, the greater part of the right lobe on the right side was removed, and there was practically no reaction. In two weeks the left side was operated on under local anaesthesia, and they removed practically all of the left side except the stump around the vessels. The neck is now fairly symmetrical, although there is still a lot of room for improvement. Pulse was 120 after second operation, temperature 101.

DOCTOR NASSAU then presented a third case, who had been referred to him at Frankford Hospital. The patient was excessively nervous, weighing 121 pounds on admission; weighs 151 pounds now. Purely toxic case with marked exophthalmos; no adenomata. Ligation without any ether. First one side and then the other. Then after a couple of weeks, he went in and took out both sides. One of the most perfect results the reporter has ever secured was in this case. The thyroidectomy was done at one sitting, because his reaction was so perfect. Pulse up to 180 after thyroidectomy.

A fourth case was then presented in the person of a man who noticed an enlargement in the neck one year ago, with all symptoms of exophthalmic goitre, thought to be purely toxic on account of the age. Ligation was done and patient allowed to go home for ten or eleven weeks. He came back, and a bilateral partial thyroidectomy was done under gas anaesthesia. All difficulties cleared up.

In response to a question, Doctor Nassau said he always ligated the superior thyroid artery.

FAT TRANSPLANT FOR PAINFUL STUMP

DR. HUBLEY R. OWEN exhibited a man whose leg had been amputated in January, 1920, at the junction of the upper and middle third of the leg. He complained of pain along the crest of the tibia, caused by pressure of his artificial leg. He also had a painful scar adherent to the internal condyle of the femur, and to the lower portion of the shaft of the femur. In December, 1921, two fat transplants were taken from the right thigh. One was placed under the painful scar of the left thigh, which was freed from its attachment to the femur, and the second transplant was placed over the crest of the left tibia. The scar of the amputation was opened, and the fat transplant was tucked underneath the skin of the stump so that the transplant made a good pad over

GUNSHOT WOUNDS OF THE FEMORAL ARTERY

the crest of the tibia. The day before the patient presented himself before the Academy of Surgery he had played eighteen holes of golf and had worn his artificial leg without pain.

Doctor Owen stated that he had several amputations which complained of pain over the crest of the tibia in spite of the fact that the stumps were apparently good and healthy, and thought that placing transplant of fat so as to pad the crest of the tibia would relieve pain in such cases.

CARCINOMA OF THE TONGUE WITH METASTASIS IN THE CERVICAL GLANDS UNDER TREATMENT WITH RADIUM AND X-RAY

DR. W. ESTELL LEE showed a patient, a man, who had been decidedly improved by the application of radium for carcinoma of the tongue. Up to the present time, four months since beginning treatment, the patient has had three applications of 100 mm. of radium, the needles being so applied as to surround the lesion and extended almost down to the epiglottis. In addition to this radium he has also had X-ray. Patient improved; pain much less, while before the use of the radium, pain was so great as to make life almost unbearable.

MULTIPLE GUNSHOT WOUND OF THE ILEUM

DOCTOR LEE presented a boy, fifteen years of age, who was admitted with history of gunshot wound from small toy pistol. Absolutely without symptoms; normal pulse, temperature, and no pain. Two cm. to the left and one cm. below the umbilicus there was a small gunshot wound. Three hours after accident an exploratory laparotomy was performed. There was only a small amount of free blood in the abdominal cavity. Eight perforations were found within one foot of ileum. Two were near the mesentery and the other six were in such a small area that it would have been impossible to close them, so a resection was performed and an end-to-end anastomosis done. The abdominal cavity closed without drainage. Patient was practically recovered in three or four days. Doctor Lee stated that he felt that resection was justified in this case because the holes were so close together that the lumen would have been practically occluded if they had been sutured. Resection was done because of the danger of producing intestinal obstruction. He believes that all the wounds could have been closed except those involving the mesentery.

GUNSHOT WOUNDS OF THE FEMORAL ARTERY

DR. GEORGE P. MULLER reported the following cases to bring out a discussion of certain points concerning blood-vessel ligation:

CASE I.—W. S., age eleven. He was admitted to the University Hospital June 7, 1918, suffering from a bullet wound in the right groin over the line of the femoral artery and one and a half inches below Poupart's ligament. The bullet had passed directly through the leg. Examination showed the leg slightly swollen, and wounds of entrance

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and exit. A distinct hum was heard over the femoral artery at the site of injury and the pulse was felt behind the internal malleolus.

The injury was treated expectantly, but in five or six days' time some purulent material was discharging from the wound. Two weeks after admission it was noted that a pulsating swelling (not expansile) was developing in Scarpa's triangle. A few days later (June 24, 1918) operation was undertaken with the diagnosis of infected haematoma. Pressure was made over the common femoral in the groin and an oblique incision made. When the haematoma was opened it was found that much of it was fluid blood and that only a scab prevented furious bleeding. The artery was found to be cut half-way through. Attempts were made to reconstruct the vessel, but this was not successful. Accordingly it was doubly ligated. The vein showed a small nick, which, however, might have been made by one of the retractors. It was ligated. In so far as he could determine the profunda femoris was present. A rubber drain was introduced through the posterior wound and the anterior wound packed with gauze saturated with dichloramine-T. In spite of this chemical the wound became freely infected, and at one time he could see the stump of the femoral artery, nearly an inch in length, beating sharply, and hemorrhage only prevented by the catgut ligature. It was thought inadvisable to use Dakin solution, and accordingly boric acid solution irrigations were practiced successfully. The boy was discharged August 8, 1918, with the wound practically healed.

CASE II.—M. F., age seven. He was admitted to the St. Agnes Hospital February 6, 1922, with a history of having been shot through the groin a short time previously. He bled profusely and was in a state of shock on admission. He was given salt solution and later 500 c.c. of blood. There was no swelling, only the wounds of entrance and exit, and no signs of bleeding from the wound. Accordingly it was decided not to practice any operative intervention. The injured leg was colder than the right leg and slightly bluish, and of course gangrene was feared. Flannel bandages and hot-water bottles were applied. The child did well reacting perfectly from the shock, and in twenty-four hours showed evidence of collateral circulation having been established. The temperature declined and was normal on the fourth day, but thereafter showed an evening rise to about 101 degrees. On February 17, eleven days after admission, he was found by the nurse in a pool of blood. A tight bandage was applied and the hemorrhage stopped, but recurred five hours later. Patient pale and thirsty. His assistant, Doctor Ryan, opened up the wound and found a hole in the femoral artery at the point where the profunda femoris is given off. The common femoral was ligated, the incision swabbed out with iodine and rubber dam drainage inserted. The patient was very ill for a few days, but on February 28 the wound was clean and granulation tissue filling it up.

Subsequently the child developed an abscess of the leg, which was incised and drained. He was discharged on May 6.

GUNSHOT WOUNDS OF THE FEMORAL ARTERY

The two points of interest that he wanted to bring out are: (1) The occurrence of secondary hemorrhage in each case, and (2) the viability of the limb after ligation of the femoral artery.

In regard to the first point, he had not made an exhaustive study, but he finds a general agreement on the dictum: "In case of primary hemorrhage, do not ligate the vessel unless it is bleeding at the time." Both of their Fellows who had written text-books of Surgery accept this rule. Makins, from the experience of the War, says: "When evidence exists that a large vessel has been wounded in the course of a track traversing the body or limbs, unless the conditions are favorable, it is not advisable to interfere primarily if no signs of progressing hemorrhage are forthcoming, nor indications that the vitality of a distal portion of the limb is becoming endangered."

As he looked back over the cases of gunshot wounds of the extremities which he had encountered, he felt that a certain degree of infection had occurred in nearly all. Different from military practice, they were admitted usually a few minutes after infliction. Different also, in that there is not the severe trauma of the tissues from the shattering blow of the shell fragment or high velocity rifle bullet.

Broadly applying the principles taught by the War surgeons, and as these wounds can nearly all be treated during the stage of contamination, not infection, he felt that in the future he would, *knowing the vessel had been cut*, promptly cut down and either suture the hole, repair the artery or ligate it, even though hemorrhage has ceased. Blood transfusion and modern methods enable surgeons mostly to disregard the shock complication.

II. Regarding ligation of the femoral artery: In 1891 Treves wrote that great risks attend ligature of the common femoral, from gangrene or secondary hemorrhage. Before the War gangrene was said to occur in 20 per cent. of femoral ligations, and in 50 per cent. where both artery and vein were ligated. Sencert (1918) is "of the opinion that ligature of the femoral artery is not as dangerous to the vitality of the limb as is commonly believed." He ligated the femoral eleven times (in three the common femoral) with no case of gangrene, where there was no large haematoma, but gangrene occurred several times in nine cases of the latter class. Makins observed gangrene in five out of thirty-five cases, and in two of these gangrene was present before operation. On the other hand, Heidrick, very recently (1921), gives detailed statistics covering cases of the last ten years. Ligation of the femoral was followed by gangrene in 20.7 per cent. He found gangrene more frequent following ligation below the branching off of the profunda than above. This is in agreement with the teaching of Treves. Ligation of the external iliac was followed by gangrene in 13.4 per cent. This again is in agreement with the older teaching of Treves and leads us to wonder whether it would not be better to expose the larger vessel through a fresh or clean incision, temporarily ligate it, and then tie

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both it and the femoral if the latter could not be repaired by suture. We had followed this principle with success for a number of years in the treatment of infected thigh stumps where hemorrhage was feared, ligating the femoral artery in Scarpa's triangle.

SUBMAXILLARY SALIVARY CALCULUS

DR. B. FRANKLIN BUZBY read a paper with the above title.

TRANSACTIONS
OF THE
NEW YORK SURGICAL SOCIETY

Stated Meeting Held April 26, 1922

The Vice President, DR. EUGENE H. POOL, in the Chair

OSTEOMYELITIS OF HEAD OF THE TIBIA TREATED BY AN
ATTACHED SKIN MUSCLE FLAP

DR. H. H. M. LYLE presented a man who was admitted to St. Luke's Hospital, November 2, 1920, with the following history:

While leading his squad against a machine-gun nest in Argonne, October 1, 1918, he was wounded by a bullet which passed through the femur, knee-joint, and came out through the head of the tibia. Five hours later he received his first dressing, being evacuated through Chalade, Villiers Dourcourt, reaching the latter evacuation hospital twelve hours later. First operation, incision with drainage, was done five days later. In the succeeding seven months he had seven operations. His leg was immobilized in a Thomas splint and the wound treated by the Carrel method. He went the usual round of the military hospitals and was finally discharged with the diagnosis of compound comminuted fracture of the femur and tibia with bony ankylosis of the knee—no sequestrum apparent.

On entrance to St. Luke's Hospital he had a discharging sinus situated on the inner side of the right tibia. The probe passed upward and inward for two and one-half inches. X-ray examination revealed a bony ankylosis of knee and an opaque injection was found to travel through the central portion of the ankylosed area between the tibia and femur.

November 8, 1920, the sinus was excised and the bony cavity thoroughly curetted and the Carrel treatment begun. The cavity was sterilized for twenty-four days.

December 3, 1920: A fat graft, taken from the abdominal wall, was inserted into the bony cavity and the skin closed over it. This failed and the graft was gradually extruded in the form of oil.

On November 12, 1921, the cavity was again curetted and sterilized by the Carrel method. Seventeen days later the cavity having been rendered sterile an attached skin muscle flap was inserted into the cavity and the skin button sutured to the mouth of the cavity. The graft took kindly and wound healed rapidly and has remained healed.

The following technic was employed: An incision five inches long was made parallel to the internal border of the tibia; the incision started on a level one inch above the sinus and two and one-half inches posterior. At the lower portion of this incision a button of skin the size of the opening of the sinus was left attached to the muscle, with a flap of muscle tissue sufficient in bulk to fill the cavity was dissected up,

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the pedicle being above and posterior to the opening of the cavity. The skin between the cavity and internal border of the tibia was undermined and the muscle flap with the attached skin button was pushed under it into the cavity. The skin button was then sutured to the edges of the sinus and the wound closed without drainage.

His personal experience with fat graft has not been very happy; the last successful one that he had has broken down nearly two and one-half years after. The success in filling base centres with viable attached muscle has been so satisfactory that he had discarded the fat graft.

WHEELER PLASTIC OPERATION ON EYELID

DR. H. H. M. LYLE again presented a patient whom he had shown before the Society six weeks ago, in the preliminary stage of the Wheeler plastic operation of the eyelid. As completed it is impossible to see where the graft has been taken from the upper eyelid and the insertion into the lower lid is scarcely visible. The result shown speaks for itself and needs no further comment.

SOLITARY CYST OF THE KIDNEY

DR. JOHN DOUGLAS said that in addition to polycystic kidney, which is probably of embryonal origin, cysts of the kidney are classified as degenerative, perinephric, retention, simple or solitary, hydatid and dermoid. Solitary cysts are of comparatively rare occurrence. They are most common in women of middle age and most frequently involve the lower pole of the kidney. Usually they are single and increase slowly in size and are symptomless until the patient notices the presence of the tumor in the upper or lower abdominal quadrant.

Urine examination is usually negative unless secondary infection of the pelvis occurs, but a differential functional test may show diminished renal function due to pressure on the kidney by a large cyst. In the same manner pressure may cause a distorted pyelogram. A radiographic shadow of the cyst may be shown and cases are reported where calcification of the cyst wall may resemble a large calculus.

As a case of kidney cyst he presented a woman, sixty-five years old, who had suffered pain in the left inguinal region for ten days before admission to St. Luke's Hospital. Her bowels moved regularly but only with severe straining. She also had increased frequency of micturition at times. She had never vomited, and while the patient said she had no fever, her daughter said that during the past year her mother had occasional chilly feelings and had felt that something was wrong in the left side of the abdomen.

On admission a cystic mass about 16 to 18 centimetres in diameter could be felt extending out of the left side of the pelvis to the level of the umbilicus. On bimanual examination it appeared to move with the uterus, and a diagnosis of ovarian cyst was made. The urine was normal except for a very faint trace of albumen and a few epithelial and many white blood-cells. Blood-pressure was 170-110. Urea nitrogen

SOLITARY CYST OF THE KIDNEY

13 mgms. and blood sugar 110 mgms. per 100 c.c. of blood. The Wassermann was negative. Radiographic examination was made as the diagnosis of ovarian cyst did not seem quite correct, but the radiogram seemed to confirm the diagnosis, as the cyst shadow could be seen rounded above and appearing to rise out of the pelvis, lying to the inner side of the sigmoid and descending colon. It was not thought to be attached to the kidney.

At operation a very thin-walled cyst was found in the left lower abdomen which was free below and was attached above to the lower pole of the left kidney. An attempt to free it from the kidney caused so much bleeding that the cyst wall was cut away from its kidney attachment, leaving a surface 3 by 2 centimetres in diameter of cyst wall, attached to the lower pole of the kidney. This surface was well cauterized by carbolic acid followed by alcohol, a rubber dam drain inserted, and the wound closed. There was little drainage and the dam was removed in five days, the wound healing by primary union. The patient left the hospital healed on the seventeenth day and has had no further symptoms.

The pathological examination of the specimen removed is as follows:

Macroscopic Examination: Specimen consists of a portion of a cyst of the kidney. It is a thin-walled sac measuring 22 x 7 c.c. and from 1 to 2 mm. thick. It shows a few coarse lobulations, but for the most part is only a thin fibrous structure with no kidney tissue recognizable.

Microscopical Examination: Sections of the wall of the cyst show a densely fibrous membrane in which a few small kidney tubules are found infrequently, and only in the thicker portions. There is no epithelial lining covering most of the surface. The blood-vessels are frequently thrombosed and hyaline areas, probably fibrosed glomeruli, are frequently found.

The origin of these solitary cysts is of interest and is still a matter of dispute. Wood writes: "In chronic diffuse nephritis of the atrophic form group of tubes may be dilated. Apparently one or more of the larger tubes in the pyramids are obstructed and this causes dilatation of a corresponding group of tubes. Such a dilatation may be moderate in size or it may form cysts visible to the naked eye." While this is an adequate explanation for the smaller cysts, often multiple, which are frequently found at autopsy, below the capsule in atrophic kidneys, it hardly explains the large solitary cysts appearing in an otherwise normal appearing kidney.

Ziegler states that these single cysts are due to retention of secretion from a glomerulus from which its tubules have been cut off and do not function, although the rest of the kidney may be normal. Aschoff quotes Ruckert that all cysts of the kidney are due to congenital tissue malformation. Most of the other writers on the subject also quote this opinion of Ruckert as does Berner, but the latter differs from him in his conclusion that all the solitary cysts of the kidney are congenital.

In the case here reported, the appearance of the kidney with the exception of the cyst was normal. There were present a few small kidney tubules and hyaline areas, probably fibrosed glomeruli, in the thicker

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portions of the cyst wall. This would suggest as the most probable cause for the cyst formation, the cutting off of some of the lower kidney pole containing glomeruli and tubules from the larger tubules due to a congenital malformation or developmental defect rather than by the growth and contraction of connective tissue, due to an inflammatory process, such as occurs and produces the multiple small cysts in an atrophic kidney.

DR. EDWIN BEER said that in a very extensive study of cysts of the kidney (note published in Professor Chiari's "Festschrift," 1908) he had arrived at the conclusion from serial section of several hundred cysts that cysts of three distinct types occurred in the kidney. The smallest cysts, never much larger than the head of a pin, were almost always derived from malpighian corpuscles and frequently at some part of the cyst wall glomerular tufts could be seen more or less atrophied. The contents of these cysts was usually colloidal material with more or less lime salts. The cysts which were next in size, growing as big as small peas, were usually of tubular origin, and in the walls of these cysts tubular epithelium could be readily recognized; the contents of these cysts was usually colloidal material, occasionally associated with lime salts. The third and largest cysts that he had encountered and studied, and to this group he believed Doctor Douglas' case belonged, were probably lymphatic in origin. A study of the walls of these cysts showed an endothelial lining with here and there in the walls accumulations of smooth muscle fibres. The largest cyst of this type that he had studied was about the size of a hen's egg. He had never sectioned cysts as large as appeared in the patient presented to-night. In the diagnosis of these cysts the pyelogram may be of great assistance, as it will show that the pelvis is distinct from the cyst, though the calyces and pelvis may show considerable distortion from pressure of the cyst against the kidney tissue. In the case presented to-night, one could readily understand how the diagnosis of ovarian cyst would be entertained and no extensive kidney studies made.

INCISIONAL HERNIA (FASCIAL FLAP OPERATION)

DR. CHARLES L. GIBSON presented a man, aged thirty-three, who was admitted to the New York Hospital, March 13, 1922. On January 1, 1916, he had been subjected to laparotomy for gunshot wound of intestine with removal of bullet from fifth lumbar vertebra. Wound broke open and healed by second intention.

Post-operative hernia became evident three months after operation. Has been increasing steadily, although he has been wearing a belt.

When admitted, protruding through the laparotomy scar was a mass the size of a child's head. It is reducible. Edges of opening can be felt. Gap estimated to be about five inches.

Operation March 15, 1922. Excision of scar tissue and refreshing of wound edges into separate layers which are united to each other. Extreme resulting tension is relieved by lateral incision anterior sheath

ŒSOPHAGEAL DIVERTICULUM (TWO CASES)

of rectus in upper three-fourths of incision. Flap about two inches wide. All sutures chromic gut.

The wound healed by primary union. Discharged March 29th.

ŒSOPHAGEAL DIVERTICULUM (TWO CASES)

DR. CHARLES H. PECK presented a woman whom he first saw on October 25, 1920, in consultation with Dr. W. W. Herrick. An œsophageal diverticulum had been discovered by Dr. Cornelius G. Coakley a few days before and the diagnosis had been confirmed by Doctor Herrick by X-ray plates and fluoroscopy. She had had trouble in swallowing with pain at times for two years, but a diverticulum was not suspected until Doctor Coakley's examination. In consultation with Doctor Herrick and Dr. H. H. M. Lyle the diverticulum was studied under the fluoroscope two days later. The position was posterior, it was pear-shaped, its convex apex reaching nearly to the level of the sternal notch. It appeared to have a fairly wide neck and its size was that of a small English walnut. Operation was advised, but the patient wished to defer it if possible, and was told that a delay of a few months would probably make little difference, as the obstruction and nutritional loss was moderate.

She was kept under observation by Doctors Herrick and Coakley until February 3, 1922, a period of fifteen months, when X-ray plates taken by Doctor Imboden showed an increase in size of at least 50 per cent. She had developed an irritating cough, which was thought to be due in part at least to pressure. Prompt operation was then advised, and on February 15, 1922, it was performed at the Roosevelt Hospital under gas-ether anaesthesia.

An incision was made along the anterior border of the left sternomastoid muscle. The omo-hyoid muscle and the great vessels were retracted outward; the thyroid gland, infra-hyoid muscles and trachea inward, exposing the œsophagus and the diverticulum freely. It was pear-shaped, about two and a half inches in length, rather broad at its base, shading off into the pharyngeal wall above. Inferiorly the angle with the œsophagus was acute. It was isolated by blunt dissection and drawn into the wound. A stomach tube was then passed into the œsophagus as a guide, and as the base was too broad for ligation. The pedicle was double-clamped about one-third inch from the œsophageal wall and the diverticulum cut away. A whip-over suture of 00 chromic catgut was placed loosely over the clamp, across the pedicle, and drawn tight as the clamp was removed. There was no leakage. A return row of stitches was taken, making the first closure secure. This line of suture was then carefully inverted by another row of the same material, taken Lembert fashion, and a third row, reinforced by a few interrupted sutures completed a satisfactory closure. The stomach tube was left in place up to the placing of the last tier of sutures to guard against narrowing of the œsophageal lumen, and was reinserted after completion of the suture to show that a good lumen was maintained. Before excising the diverticulum a coffer-dam pack of gauze had been placed at the lower angle of the wound to the inner side of the great

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vessels, against the trachea and cesophagus, to wall off the mediastinum and protect it against future leakage. This was left in place and a second pack was placed above for further protection at the end of the operation. Temporary packs used during the operation were removed before placing the second permanent pack. A small additional rubber tissue drain was also placed just below the suture line, but not in contact with it. The upper part of the wound was closed with catgut and silk to the exit of the drains.

The permanent packs to protect the mediastinum are a necessary precaution as the cesophageal tissue heals poorly and some leakage before healing is complete almost invariably occurs. The time of operation was one hour and twenty-five minutes; the patient's condition remained good and there was very little post-operative temperature and pulse reaction.

Fluids were given by rectum with absolutely nothing by mouth for four days; broth and albumen water were commenced on the sixth day. The patient could not speak above a whisper for five days, but the voice began to return on the fifth day. On the seventh day, 40 ounces of fluids were taken by mouth. During the night of the seventh day leakage from the wound occurred for the first time, and thereafter there was some leakage with each ingestion of fluid, but at no time did it amount to any considerable proportion of the fluids swallowed. By March 3rd, sixteen days post-operative, the leakage had practically stopped, though a very little occurred from time to time. The permanent packs were removed by stages, commencing about the tenth day and were all out by the twelfth day. She left the hospital on the twenty-second day after operation (March 9th), and after March 14th (twenty-seven days post-operative) had no food leakage whatever. Soft solids were commenced on the ninth day and ordinary light diet on the twelfth day. The wound healing has progressed steadily and without incident and is now nearly complete.

The patient has now practically no discomfort in swallowing and eats ordinary food without difficulty.

DR. CHARLES H. PECK presented a second case of cesophageal diverticulum, a woman thirty-nine years of age, who was referred to him by Dr. Charles H. Mayo and Dr. G. J. Jackowitz, and was first examined by him August 24, 1921. A diagnosis of cesophageal diverticulum had been made and X-ray plates showed a good-sized pouch, placed posteriorly, its apex reaching nearly to the level of the sternal notch. No mass could be felt by palpation. Swallowing of solid food had become increasingly difficult and some regurgitation occurred at each meal, though she had as yet little apparent loss of nutrition. Operation was advised and performed on October 8, 1921, in one stage.

The technic followed was identical with that described in the previous case. A stomach tube was used as a guide to ensure a sufficient lumen after suture. The pedicle was divided with a cautery between clamps and a careful whip-over suture with fine chromic gut taken in three tiers. Cofferdam packs were placed below in the wound, the two lower ones to remain for ten or twelve days, and a temporary drain just

ŒSOPHAGEAL DIVERTICULUM (TWO CASES)

below, but not in contact with the suture line. Fluids by mouth were withheld for four days, and a 5 per cent. glucose solution was given regularly per rectum.

For twelve days there was no leakage of ingested fluids or food, but on the thirteenth day a leak occurred, and thereafter recurred at each feeding in decreasing quantity for about ten days, the last noted being on November 1st, twenty-three days after operation.

The wound was completely healed by December 1st, fifty-three days after operation. The patient has been able to take food in normal quantities without distress or regurgitation since the closure of the fistula.

Zenker and Ziemssen described pulsion diverticulae of the oesophagus in 1877 and expressed the hope that some day operative treatment might be possible.

Judd, in 1918, reported thirty-five cases from the Mayo Clinic and stated that up to that time 150 cases had been reported in the literature.

Difficulty in swallowing, regurgitation of food, a feeling of an obstruction in the throat, a gurgling noise on swallowing in some cases; and later in advanced cases, a distinct loss of nutrition are the chief symptoms.

The majority of the cases are above forty-five years of age before symptoms lead to surgical treatment. The average age in Judd's series was fifty-five years. Palpable or visible tumor was present in ten of the thirty-five cases.

Of all the cases of diverticulum of the oesophagus operated upon by him, a one-stage operation was done in twenty-two cases; a two-stage operation in ten cases, and the Bevan operation of inverting the sac three times.

There were two operative deaths in the series, both aged men (seventy-three years and seventy-six years old), and bad risks—one after a one-stage, and one after the first step of a two-stage operation.

DR. WILLIAM A. DOWNES said that he had shown a case before this Society some ten years ago in which he had removed an oesophageal diverticulum. In that case he accidentally removed about one inch of the oesophagus and had to do an end-to-end suture. Only recently he showed the patient again with an accompanying röntgenogram and she has no constriction and the result has been perfectly satisfactory.

DOCTOR PECK said that he had remembered Doctor Downes' case when he was operating on this patient, and had profited by it to the extent of putting in a stomach tube as a guide. It is difficult when the diverticulum is drawn out to say where the oesophagus begins and the diverticulum ends. It is surprising how little one has left of the pedicle to turn in. A normal-sized stomach tube in the oesophagus is a help. If enough is left to invert there is not much to trim away. It would be difficult to do the operation, to carry out the careful suturing, under local anaesthesia. The drainage was kept well below the suture line.

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SARCOMA OF NASAL FOSSA

DR. CHARLES H. PECK, to show the late result, presented a patient who is well and free from recurrence eleven years after excision of a round-celled sarcoma of the left nasal fossa, involving chiefly the region of the middle turbinate and adjacent part of the ethmoid. The tumor had recurred twice after partial removal through the nostril. The diagnosis of round-celled sarcoma was made by Dr. Mortimer Warren from sections of tissue taken at the second operation and confirmed by examination of the growth after the radical operation by the same pathologist. The final operation was done by him February 7, 1919.

The mucous membrane of the maxillary antrum and frontal sinus was excised, but showed no involvement. The sphenoid cells were opened during the operation, but seemed normal. The nasal process of the maxilla, the left ethmoid and lachrymal (inner wall of the orbit) : the inner wall of the maxillary antrum and a portion of the bony wall of the frontal and sphenoidal sinuses were removed.

The case was presented before this Society on March 22, 1911, and the operation reported in detail and published in the *ANNALS OF SURGERY*, vol. liii, 1911, p. 856.

Intratracheal anaesthesia was given by Dr. Chas. A. Elsberg, the first case in which it was used at the Roosevelt Hospital, and greatly facilitated the ease and safety of the operation.

The patient had long been lost track of and was thought to have died long ago. He was found by chance about four weeks ago, and is presented as a rather striking example of recovery from round-celled sarcoma after radical removal. He was forty-five years of age at the time of operation—fifty-six years at the present time. No post-operative treatment by toxins or X-ray or radium was ever used.

DR. ALEXIS V. MOSCHCOWITZ said that this is a very rare condition. He had operated on one such patient in 1917 and the patient is still without any recurrence. The speaker had used an incision different from that of Doctor Peck and the cosmetic result was beautiful. He used an incision going from the middle of the eyebrow down the bridge of the nose, so as to spread the nose; this gave a wide entrance to the ethmoid, enabling the easy removal of the tumor, and the resulting cicatrix was barely visible.

THE SURGICAL VALUE OF THE ESTIMATION OF THE BILE
PIGMENTATION (ICTERUS INDEX) OF THE BLOOD SERUM

DR. DE WITT STETTEN read a paper with the above title, for which see page 191, *ANNALS OF SURGERY*, vol. Ixxvi, No. 2.

MR. ADOLPH BERNHARD (by invitation) said that when Doctor Stetten came to him last fall and asked him to take up the question of bile in the blood, he showed a very simple method for its determination. At the time this work had been confined to the medical side of the hospital and he had been greatly pleased to learn that a surgeon could get so much out of a simple laboratory test. The details of the test are simple. Blood is taken as for a

SARCOMA OF THE SMALL INTESTINES

Wassermann and the serum compared with standard solution, dilution of the serum with salt solution being resorted to when the color is too dark for comparison. The delicacy of the test has been amply demonstrated by Doctor Stetten. One might compare the icterus index in jaundice cases to creatinine in the blood in nephritis. A rise in creatinine means a poor prognosis, a low creatinine a good prognosis. A rise in the icterus index would indicate an increase in the amount of jaundice; a fall in the icterus index means that the jaundice is decreasing. It is difficult to tell if jaundice is decreasing simply by inspection of the skin or sclera. There has been a fall of 40 points in the icterus index of a patient in whom no change in the sclera or the skin could be observed.

DR. ALLEN O. WHIPPLE was mostly interested in that part of Doctor Stetten's paper in which he referred to the determination of the amount of bile present in post-operative cases. He considered it very difficult to determine from the color of the patient's faeces or of the skin or sclera whether obstruction has been relieved, and yet it is very important to know if the common duct lumen is re-established. That part of the test alone would make the work Doctor Stetten has done of very real value.

DR. HUGH AUCHINCLOSS asked if there were comparisons made with the blood concentration at the same time the tests were made. Many of these patients are dehydrated when they are first seen and then are given fluid in many ways. He wished to know if there is enough concentration of blood and decrease of body fluid to make an appreciable difference in the determination of the icteric index.

DOCTOR STETTEN, in closing, said that while various other comparative studies have been made, the special point that Doctor Auchincloss mentioned has not been taken into consideration. Most of these cases are not especially dehydrated and there had not seemed to be any occasion for studying the blood concentration in relation to the icterus index. An attempt, however, had been made to see whether cases with nitrogen retention showed increased bilirubinaemia due to poor elimination, but as yet no definite results have been obtained. A further effort had been made to find if there is any relation between the icterus index and delayed coagulation time, calcium deficiency, and hemorrhagic diathesis, but up to date the results have been very inconclusive and in some instances contradictory. Another problem that is being taken up is to see if the index determination will throw any light on that dread sequel to operation, namely post-operative cholæmic coma. It cannot yet be stated whether an excessive bilirubinaemia, an acidosis, due possibly to bile-acid intoxication, or merely an hepatic insufficiency, play the most important rôle in this not unusual complication.

SARCOMA OF THE SMALL INTESTINES

DR. JOHN DOUGLAS presented a specimen (Fig. 1) on which he commented as follows:

The surgery of a malignant disease brings with it many disappointments. Therefore a particularly favorable result, when the prognosis at the time of

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operation seemed bad, is worthy of report if only as an encouragement to perseverance and the carrying out of as radical an operation as possible.

A man, thirty-six years old, was admitted to St. Luke's Hospital, December 23, 1916. He had been treated intermittently for lues for fifteen years. For eighteen months previous to admission he had indigestion, apparently intestinal in nature, with attacks of colicky pain at intervals. These attacks became more frequent and severe and the loss of flesh more marked. The day before admission he had a very severe attack and vomited. When seen before entering the hospital, his abdomen was distended, the distention being in the small intestine, and visible peristalsis was most evident, the coils of distended small intestine being plainly visible beneath the thin abdominal wall. In the right lower quadrant a mass could be palpated which felt as if there were an intussusception of the small intestine, rising up out of the pelvis with each peristaltic wave and disappearing as the muscular contraction ceased. A diagnosis of intestinal obstruction due to intussusception of the small intestine perhaps caused by a tumor was made, and immediate operation advised.

At operation there was found a tumor in the lower ileum infiltrating its wall so that the lumen was about five-tenths centimetre in diameter. Above this constriction the intestine was greatly distended, thickened, and edematous. Below it was constricted and collapsed. Resection of the tumor, together with 10 cm. above and 4 cm. of the intestine below the growth with the mesentery attached, was done and an end-to-end anastomosis performed. A number of enlarged glands were removed from the mesentery.

The following is a description of the specimen removed:

Macroscopical Examination.—Specimen consists of a portion of the ileum from about its middle part measuring 16 cm. long by 5 cm. in diameter. The proximal portion is thick walled, leathery feeling, and at the distal part of the specimen is a white constriction band 2.5 cm. broad which when cut into shows a very soft homogeneous mass, projecting into the lumen. Within the central portion of the neoplasm is a small lumen slightly larger than a lead pencil and showing a mucosal lining. No ulceration is evident. (N. B.: Many nodes apparently involved were found at operation.)

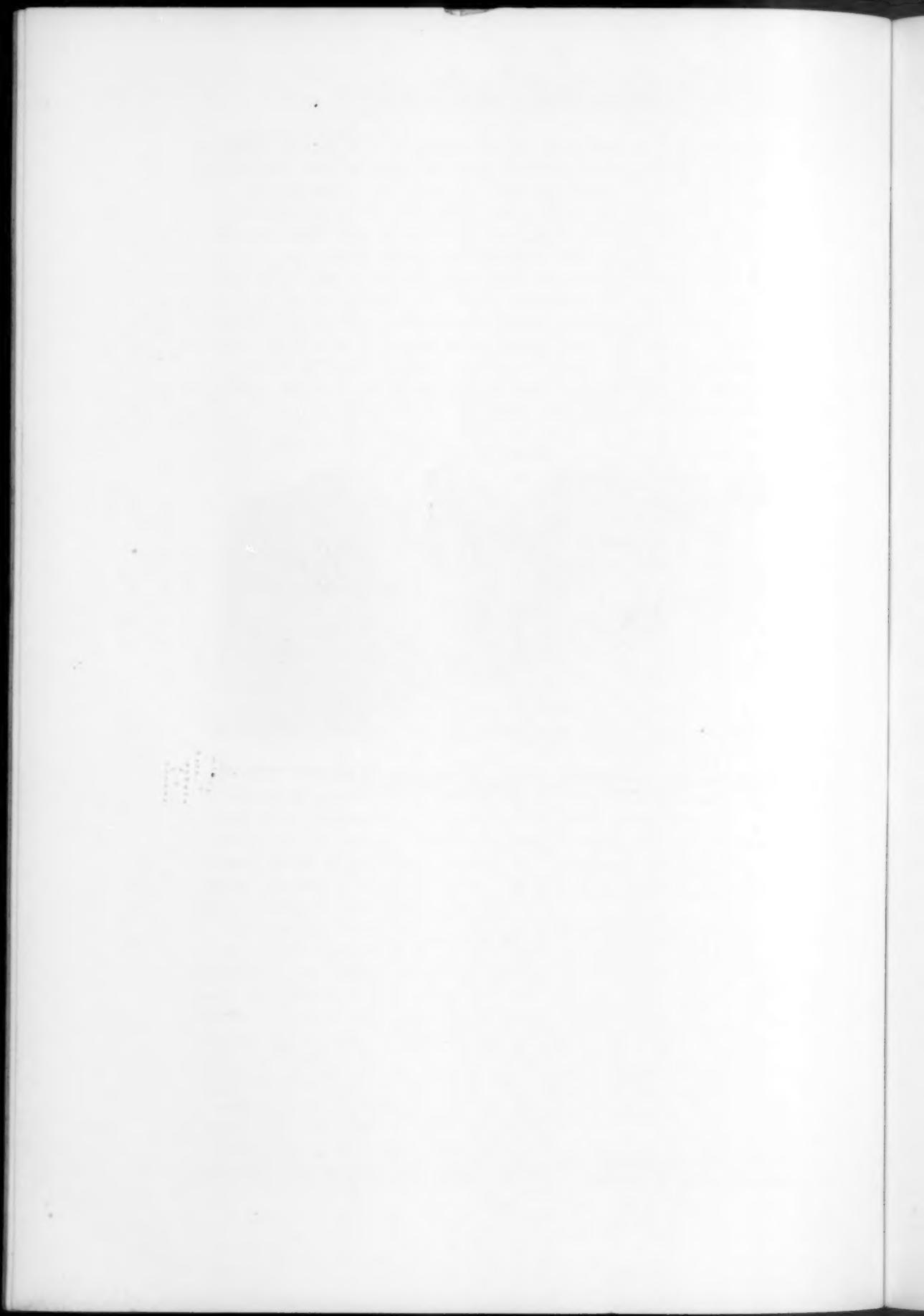
Microscopical Examination (by Dr. F. C. Wood).—Section through tumor mass of intestine shows muscle wall which is infiltrated with lymphoid cells. Beneath this are masses of lymphoid cells and some soft reticulated stroma. Few blood-vessels are seen with indefinite walls. Some of the lymphoid cells are swollen. There are a few mitotic figures seen. Section shows a lymph-node with a decrease in lymphoid follicles and an increase in fibrous connective tissue. Some polymorphonuclear cells are seen. There are no mitotic figures.

Diagnosis: Lymphosarcoma of intestine (ileum). Lymph-node chronically inflamed. Possibly metastasis.

The post-operative course of this case was uneventful. He left the hospital three weeks after operation and a recent report in January,



FIG. 1.—Sarcoma of small intestine. Note constriction below, dilatation above tumor and attempt at intussusception into dilated portion.



SARCOMA OF THE SMALL INTESTINES

1922, more than five years after his operation, states that he is in the best of health.

Sarcoma of the small intestine is of quite infrequent occurrence in comparison with the large number of cases of carcinoma of the large bowel. In 1912 he reported a case of sarcoma of the small intestine operated on in Bellevue Hospital. At that time the most complete analysis of the subject was the work of Lecène who had collected eighty-nine cases up to 1907. He was able to find only nineteen additional reported cases, including his own, up to 1912, a total of 108. In 1914 Speese made a careful analysis of the eighty-nine cases collected by Lecène and twelve additional cases from the literature, 101 in all. The most recent review of the recorded cases of sarcoma of the intestines by Goldstein, published in August, 1921, records 130 cases, including those in the large intestine and rectum; and as it is stated by Bottomley that 65 per cent. of intestinal sarcoma are found in the small intestine, the number of reported small intestine cases has not greatly increased. Its relative frequency in comparison with sarcoma of the stomach is shown by the fact that he was able to find 240 recorded cases of the latter in 1920 and Goldstein has collected 265 cases in 1921.

The relative occurrence of other tumors of the small intestine is shown by a paper published by E. S. Judd, who reports twenty-four cases of carcinoma of the small intestine compared with 1822 in the large intestine and rectum and 1689 in the stomach. Judd calls attention to the fact that the carcinomas of the small intestine differ from the ordinary carcinoma of the large intestine in that most of them develop on polypi or papillomata and in only a few instances followed the type of true colloid carcinoma usually found in the large bowel.

Pathology.—The types of tumor in the cases collected by Speese were lymphosarcoma thirty-four, round-cell forty-three, spindle-cell thirteen, fibrosarcoma three, myxosarcoma two, myosarcoma two, melanosarcoma one, and mixed type three. My own two cases not included in this list were lymphosarcomata. Both followed the type of infiltrating growth usual in lymphosarcoma. The small pedunculated tumors are generally of the spindle-cell type. The tumor is most frequently found in the ileum. As a rule the growths are single. Rarely multiple growths are present. Ulceration occurs in over half the cases, but cicatricial contraction, such as occurs in carcinoma, causing stenosis and obstruction, is uncommon. Intussusception is not infrequent. The accompanying illustration shows the effort of the intestine to produce an intussusception in the case reported. Perforation is rare but has occurred.

Symptoms.—The first symptoms noticed are usually the presence of the tumor in the abdomen, abdominal pains or discomfort. There may be intermittent distension, but complete obstruction is rare. When obstruction does occur, it is usually due to growths in the mesentery or to kinks or adhesions of the intestine. A small tumor causing intussusception may produce the first symptoms of the growth. Anæmia and cachexia appear quite early, the latter being the usual cause of death. Ascites is uncommon, as sarcoma does not form metastases on

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the peritoneum as does abdominal carcinoma, although it may infiltrate the mesentery or omentum. While melena may occur, this is less frequent than in carcinoma because the growth is less likely to ulcerate.

This symptomatology differing, as it does from that of carcinoma of the large intestine, is what one would expect from the difference in pathology. In the reported cases the disease has occurred twice as frequently in males as in females.

Prognosis.—It is stated that the duration of illness in round-cell and lymphosarcoma is four to six months. In spindle-cell sarcoma, eight to ten months. The mortality of operation is high, but of course depends largely on the extent of the growth, the amount of infiltration, adhesions to other structures, condition of the patient, glandular involvement, etc. In the series of forty cases reported by Moynihan in 1906, it was given as 57 per cent. There was a mortality of 26 per cent. in the seventy-five resections collected by Speese in 1914. Bottomley writes that "recurrences" are almost certain to take place and Bondareff states that recurrence occurs in 95 per cent. of the cases of round-cell sarcoma, although he reports one case without recurrence for three years, and Steinthal records one free for three and a half years; also a case of spindle-cell sarcoma free for four years after operation. The reporter's first case operated on ten years ago was lost track of shortly after discharge from the hospital, although he had gained 22 pounds in the three months after operation.

The use of post-operative radiotherapy should prove of value in diminishing the percentage of recurrences, especially in lymphosarcoma, as this type of neoplasm in the superficial lymph-nodes at least seems one of the most amenable to this form of treatment. It is worthy of note, however, that the case reported free from recurrence for over five years received no radiotherapy or Coley's toxines after operation.

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Stated Meeting Held May 10, 1922

The President, DR. JOHN A. HARTWELL, in the Chair

ACUTE OBSTRUCTION OF SUPERIOR MESENTERIC VEIN

DR. DEWITT STETTEN presented a man, forty years of age, who on January 9, 1922, was operated on by Dr. Hermann Fischer for a huge retroperitoneal tumor below the left kidney. The tumor was

ACUTE OBSTRUCTION OF SUPERIOR MESENTERIC VEIN

removed and a left nephrectomy was performed at the same time. Microscopical examination of the tumor showed it to be a carcinoma, possibly of testicular origin, although both testicles were normal and in the scrotum. The patient made an uneventful recovery and was discharged on February 7, 1922, with a superficial lumbar sinus. The patient rapidly improved, gaining thirty pounds in weight.

He was feeling perfectly well until 3 A.M. on March 14 when he awoke with severe abdominal pain and vomited. That afternoon he was admitted to the hospital. He had severe abdominal pain and vomited large quantities of bile-stained fluid. His temperature was 100° F., pulse 80 and good quality. There was slight tympanites and definite sensitiveness and rigidity in the right iliac fossa. Leucocytes 20,000 with 90 per cent. polymorphonuclears.

The following morning the patient's condition seemed to have improved. His pain was less severe, his vomiting had ceased and his temperature and pulse were normal. The abdomen was no more distended and the sensitiveness and rigidity on the right side had, if anything, diminished.

During the course of the afternoon the pain and vomiting began again and toward evening became more severe. The leucocytes had risen to 37,000 with 88 per cent. polymorphonuclears. That night the patient's condition changed decidedly for the worse. Although his temperature was still normal, his pulse had risen to 140, its quality thin and thready and his appearance was one of collapse. He was vomiting continuously and writhing in extreme agony. The distention had noticeably increased, likewise the sensitiveness and rigidity in the right side of his abdomen. No gas had been expelled and signs of peritonitis irritation were also evident on the left side.

With a tentative diagnosis of acute appendicitis and spreading peritonitis, operation was performed at 10 P.M. March 15, 1922 (43 hours after the initial symptom).

A right rectus incision was made. Before incising the peritoneum a bluish discoloration was noted beneath it. On opening the abdominal cavity, a stream of bloody serum under considerable pressure gushed out, and it was seen that a large quantity of this fluid was present in the abdomen. A somewhat distended loop of small intestine of a deep purplish-black color presented. Other loops in the neighborhood were examined and all showed the same discoloration. The appendix was not even searched for, but the caecum was seen to be much contracted, slightly injected and reddish in color. A diagnosis of either a mesenteric thrombosis, torsion of the mesentery or strangulation of some sort was made, and a median hypogastric laparotomy was rapidly performed. With the exception of a small, high jejunal loop of about six inches in length, which, though somewhat distended, was of rather normal color, the entire small intestine showed the same discoloration as the loops previously examined through the appendix incision. An attempt was made to find a twist in the mesentery or a band constricting it. No actual twist of the mesentery could be found and the intestines

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were then eventrated for exploratory purposes. Except for a small portion of the mesentery leading to the above-mentioned loop of comparatively normal jejunum, which was thin and felt and looked normal, the rest of the mesentery of the small intestine was densely infiltrated, at least one cm. in thickness, reddened, edematous and hemorrhagic in spots. In places the ileum showed ecchymotic areas at points opposite the mesenteric attachment. Pulsation of the superior mesenteric artery was not noted, nor were any constriction furrows seen. The intestines were spread out in a fan-shaped fashion and nothing further was found. Nowhere could evidence of recurrence or metastases be detected. On the assumption that there was present a hopeless mesenteric thrombosis involving probably the circulation of almost the entire small gut, the intestines were rapidly replaced in what appeared to be their normal position. A suspicion of a change of color as they entered the abdominal cavity existed, the bluish-blackness seeming to have diminished a trifle, although not very definitely or conclusively. The abdominal wounds were rapidly closed under great pressure from the anaesthetist, the patient's condition having become very alarming in spite of stimulation and intravenous infusion. On several occasions the anaesthetist reported that the patient could scarcely survive more than a few minutes, that he had ceased breathing and was pulseless, but, in spite of this, the patient was brought back to bed still alive but in extreme shock. The usual stimulation, Murphy drip, etc., were ordered although it was felt that the prognosis was utterly hopeless. By the following morning the patient had improved considerably. His pulse was much better, he had had a bloody, diarrhoeal stool, and his distention had subsided. His vomiting and pain had ceased; there was a slight rise of temperature. Stimulation and a $2\frac{1}{2}$ per cent. glucose continuous intravenous drip were given. During the day the improvement continued. He expelled gas, his pulse steadily picked up, and toward evening he made the impression of a convalescent patient. On March 17 the patient's temperature had come down to normal, his pulse was 90, full and excellent quality. He had not vomited since the operation and his bowels had again moved spontaneously. His abdomen was flat, soft and insensitive. He took nourishment freely and all stimulation was discontinued. From this date on an uneventful recovery ensued with primary union of both wounds.

The only explanation of this rather unusual set of symptoms, according to the reporter, is the following: Owing to the growth of the large abdominal tumor the intestines with their mesentery had been pushed over to the right side of the abdominal cavity. Upon the removal of the tumor a defect existed which permitted the intestines to fall over to the left. From some sudden turn or twist on the part of the patient a kink occurred in the mesenteric radix which temporarily obstructed the return flow in the superior mesenteric vein. In the manipulations, while exploring intestines and the mesentery, he unwittingly corrected this abnormal position, replaced the intestines in their proper relation to the mesentery, straightened out the kink and relieved this venous obstruction.

INTUSSUSCEPTION OF THE APPENDIX

DR. ALFRED STILLMAN referred to a case in which Doctor Peck had recently done a laparotomy. On opening the abdomen he discovered a mesenteric thrombosis, the whole gut being dark colored. He felt he could do nothing to relieve the condition and so closed the wound. Nevertheless the patient made a complete recovery.

DR. WILLIAM A. DOWNES spoke of a case which he showed many years ago before this Society, a child, whose abdomen on being opened was found filled with bloody serum and the entire small intestine had this same appearance as described by Doctor Stetten. It was considered to be a mesenteric thrombosis. As the entire small intestine was involved resection was out of the question. Thinking that a line of demarcation might be established and resection done later, the small intestine was brought out on the abdominal wall and covered with a rubber dam. Twenty-four hours later the natural color had reappeared and the intestine was dropped back and the abdomen closed. The patient made a perfect recovery. No doubt the child had some passing circulatory disturbance. These cases should be watched with great care and the treatment should be conservative.

DOCTOR STETTEN, in closing the discussion, said that cases had been reported of spontaneous recovery from mesenteric thrombosis (Klein, E., *Surgery, Gynecology and Obstetrics*, 1921, vol. xxxiii, p. 385), although these reports are all somewhat dubious. There is no question that the case presented was not an actual volvulus. No twist or strangulation of the mesentery or gut could be found. The lesion in the mesentery was very definite and marked. The mesentery resembled strongly that found in a strangulated hernia. It was felt that there had been a kinking of the root of the mesentery owing to the disturbed relations in the abdominal cavity due to the presence and later the removal of the retroperitoneal tumor. With this kinking the thinner walled vein was obstructed while the thicker walled artery apparently continued functioning, thus causing the intense venous obstruction of the gut and its mesentery. The kink and the obstruction were both relieved by the operative manipulation.

INTUSSUSCEPTION OF THE APPENDIX

DR. CHARLES E. FARR presented a girl, now ten years of age, who on June 5, 1917, at the age of five years was brought to the hospital complaining of moderate pain, of four days' duration, in the left side of the umbilical region which at onset had been relieved by an enema. On June 4 she had vomited greenish fluid, and a local physician had found a lump to the left of the navel. The appetite was good, bowel movements normal, and she slept well. Physical examination showed a child quiet, almost apathetic, with a hectic flush, but not looking acutely ill. Head and neck normal, tongue slightly furred, heart and lungs normal. The temperature was normal, white blood-cell count 39,000, polymorphonuclears 80 per cent., urine negative, Von Pirquet negative. A diag-

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nosis was made of intussusception and the patient was operated upon at once. There was no fluid nor were there any tubercles in the abdomen. The appendix and part of the cæcum was found invaginated into the ascending colon. It could not be entirely reduced and part of the cæcum was excised with the appendix. The wound was closed and the patient made an uneventful recovery. Microscopical examination of the specimen removed showed all coats oedematous, blood and lymph-vessels dilated and infiltrated with leucocytes. The lymphoid tissue was extremely hyperplastic and the appendix acutely inflamed.

DOCTOR FARR presented a second case of the same condition, also a little girl five years of age, who was admitted to the hospital March 31, 1922. She had been ill for five days with abdominal pain, and had vomited much greenish material and "phlegm" at onset. The pain was especially severe in the right lower quadrant and was intermittent, at times causing her to lie doubled up and unable to sleep. Temperature was found to be 98, pulse 110, respiration 28. The white blood-cell count was 10,600, polymorphonuclears 85 per cent., urine negative. In the right side of the abdomen could be palpated an indefinite mass, fairly well fixed. The child was not prostrated, but appeared toxic. Diagnosis of intussusception or appendicitis was made and operation was done at once. There was a little free fluid and the appendix was found invaginated into the cæcum exactly as in the other case. The constricting ring was dilated. The appendix was delivered with great difficulty and removed, the base being inverted. The wound healed with a slight stitch abscess.

In both cases the meso-appendix prevented complete invagination. The appendix was caught by the cæcum and could neither get in nor out. The result of non-operative treatment might possibly be a sloughing of the base of the appendix and the retention of the tip, but the danger of peritonitis would be very great.

DR. HUGH AUCHINCLOSS referred to a case of perfectly distinct intussusception of the appendix into the cæcum operated upon by Doctor Blake some years ago. A section was cut from it and the coats demonstrated inside out, the whole appendix lying inside the cæcum.

Dr. HERMANN FISCHER spoke of a case of intussusception of the appendix that he showed before the surgical section of the Academy several years ago. The patient was a woman of about forty-two years of age who had a partial obstruction from a tumor of the transverse colon which was thought to be a carcinoma. On operation a colo-colic invagination was found. This could only be reduced to the point just above the cæcum which was very much thickened by oedema. The appendix which was very large, about the size of the lower ileum, was distended by thick mucus and half-way invaginated into the cæcum. This large mucocele of the appendix was undoubtedly the cause of the invagination. The cæcum was resected and an ileocolostomy was done. The patient made an uneventful recovery.

SUPPURATING ARTHRITIS OF THE KNEE

SUPPURATING ARTHRITIS OF THE KNEE

DR. CHARLES E. FARR presented a boy, five years of age, who was brought to the hospital April 19, 1922. Four days previously he had fallen and cut his left knee on a broken milk bottle. There was swelling and pain and the child was unable to sleep. Temperature was 102.4° , pulse 108 and respiration 28, rising to 104° , 140, 30. White blood-cell count was 29,800, polymorphonuclears 88 per cent. on April 20th. A smear of the exudate from the knee showed many pus cells, cocci in pairs and short chains; culture showed a mixed growth of staphylococci and streptococci. Urine was negative. Operation, performed April 21, consisted of a long incision on either side of the joint, which was widely opened, allowing the escape of much pus and large fibrin clots. The joint was washed out. No drains were used and active motion was enforced from the very beginning. The result after nineteen days is a nearly complete return of function.

DR. DEWITT STETTEN said that recently he had had two cases of infectious arthritis of the knee which had been treated by mobilization, one, a metastatic pneumococcus infection and the other an extension from a staphylococcus osteomyelitis of the lower end of the femur. The pneumococcic case had been incised and drained and the other case had been punctured and irrigated. Both had been doing badly. When he put them on the Willems' treatment both rapidly recovered from their sepsis. As far as the mobility is concerned that is another problem. In neither of these two cases was the mobility entirely satisfactory, although both have a certain amount of motion. In the pneumococcic case there is a fixation of the patella and extension is practically nil, although flexion is rather satisfactory. Doctor Stetten proposes later to mobilize the patella. In the other case the patella is loose and there is moderate flexion and extension. What was most impressive was the rapid recovery from the sepsis. Both cases were free from fever within a week after the treatment was instituted.

DR. ALFRED STILLMAN said that there was, on the second surgical division at Roosevelt Hospital, a boy five or six years of age who had traumatic synovitis which became a suppurative affair and was incised on both sides of the patella. He was subsequently able to move the leg and got complete flexion. If these patients can be operated upon early enough it is possible to secure their coöperation in recovery of mobility.

DR. JAMES M. HITZROT said that while early motion was a very necessary thing in infections of the joints, from his experience the type of the infecting organism was more important in predicting the ultimate function, and the prognosis as to ultimate function depended upon the action of the infecting organism on the cartilage of the joint. Certain infections produce chondrolysis very rapidly. In these the prognosis is bad and ankylosis occurs. The staphylococcus aureus was particularly prone to produce early chondrolysis, while the haemolytic streptococcus and other organisms produced little or no cartilage change in the early stages.

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MYOSITIS OSSIFICANS

DR. JAMES M. HITZROT presented a boy, aged sixteen, who was admitted to the New York Hospital, First Surgical Division (Cornell), September 21, 1921, complaining of pain in the right groin and inability to walk, due to the position of his right leg. The condition began two weeks before admission with pain on the inside of his right leg high up, then he began to limp and his leg became flexed at the hip. For about a week he had had to keep very quiet because the pain was increased by walking. There was no history of any definite injury, but at the onset he felt as if he had strained his leg, otherwise the history was negative.

On admission he looked fairly well, seemed comfortable as he lay in bed. His general examination was negative. In the right lower abdomen, extending down below Poupart's ligament, was a hard mass whose outlines could not be definitely defined. The leg was flexed, abducted and rotated out at the hip, and could not be fully extended. Active movements in flexion were almost complete. Internal rotation almost completely absent, external rotation practically absent. Forced movements in extension and rotation at the hip were painful. The thigh was atrophied. Motions at knee and ankle normal. Spine normal. With patient on his face, extension of right hip was markedly limited and quite painful.

Clinical Examination : Blood—red blood-cells 4,900,000, white blood-cells 7400, polymorphonuclears 63 per cent.; urine negative, Von Pirquet positive, Wassermann negative. X-ray examination negative; both sacro-iliac joints suggest some change, possibly due to infection. Vertebrae and hip-joint are normal in appearance.

The clinical diagnosis was a lesion of the iliopsoas muscle, possibly due to infection in the wing of the ilium.

October 20, 1921, a three-inch incision was made from the anterior superior spine of the ilium toward the symphysis. The tumor mass was found to be bone, cancellous in character, which extended up into the iliac fossa. The mass was then fully exposed and found to be a bony mass in the body of the iliacus muscle which extended to about one inch above the lesser trochanter. The mass was encapsulated and not adherent anywhere and was completely excised. Wound closed with small rubber drain at lower angle.

Convalescence was uninterrupted and the patient was discharged on sixteenth post-operative day. Extension of thigh now complete.

Four months follow-up notes: Movement at hip slightly restricted. Flexion complete. Extension limited to 10 degrees. External and internal rotation about one-half normal. Patient walks without limp or pain.

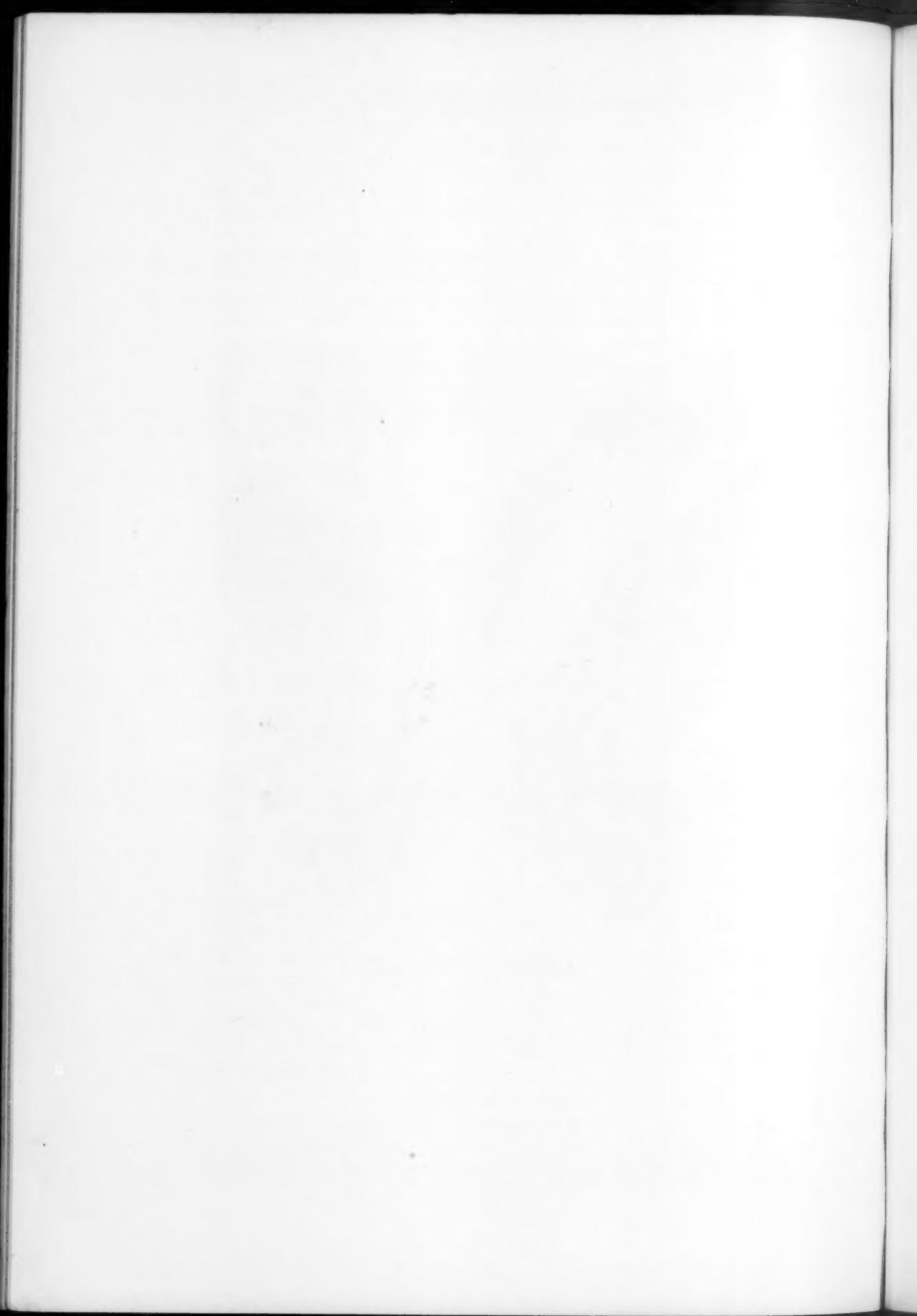
Pathological Report: Ossifying myositis with attached muscle fibres undergoing atrophy and interstitial changes. The mass was encapsulated.

CARCINOMA OF STOMACH

DR. JOHN A. HARTWELL presented a woman, age twenty-five years, with the following history: In May, 1921, she suffered an acute attack of abdominal pain without previous symptoms, which was diagnosed



FIG. 1.—Diffuse carcinoma of stomach, showing portion removed at operation. Section obviously made through neoplastic tissue.



CARCINOMA OF STOMACH

as acute appendicitis. An immediate appendectomy was done and no statement is made by the operator as to any examination of other organs. Following the operation the attacks of pain continued and to these were added intense pain on taking food with practically constant vomiting. At the time of admission to Bellevue she was able to take no nourishment whatever because of the very intense pain and persistent vomiting. She was markedly undernourished, weight 94 pounds, and very feeble. Examination showed a hard, cylindrical tumor extending from the left costal region to the pyloric region. Its diameter was about 3 inches and length 8 or 10 inches. It was of a stony hardness. The X-ray showed an involvement of the entire stomach by a rigid tumor mass; practically complete obstruction of the pylorus, but no dilatation of the stomach, owing presumably to the rigidity of the stomach wall.

December 16, 1921, the abdomen was opened. The stomach was found to be the seat of a diffuse carcinoma involving the entire wall of the stomach throughout its whole length up to the diaphragm. The process was, however, less advanced at the cardia than at the pylorus. Gastro-enterostomy, obviously, would have been of no avail, and it was therefore determined to remove as much of the stomach as possible by the Poliya-Reichel method. This was accordingly done, cutting through the stomach as high up on the cardia as possible, though it was obvious the section was through very marked disease. The gastro-jejunal anastomosis done so high on the stomach and in such a rigid organ produced a marked angulation of the jejunum. A jejuno-jejunostomy between the afferent loop and the efferent loop was therefore added.

Post-operative convalescence was entirely smooth. Food began to be taken at the usual interval without pain. At the present time the patient has gained 30 pounds; maximum weight having been 124 pounds. She is taking food without pain and without vomiting, and on physical examination there is no evidence of a mass in the stomach region. She has received two treatments of X-ray therapy at the Memorial Hospital.

The pathological report, Bellevue Hospital laboratory, is as follows: Gross—Specimen is a portion of the stomach from the pylorus to a point about 12 cm. proximally. The pylorus is apparently normal but just proximal to it there is a marked constriction. The wall of the stomach is thickened, measuring from one-fourth cm. to two cm. Much of this thickening is inside the muscularis and forms a white homogeneous, firm sheet, encircling the stomach. This layer appears at the proximal end of the specimen where it is quite thin (Fig. 1).

Microscopic: Diffuse carcinoma, quite cellular between and below the glands. Below this, islands of cancer cells (small but hyperchromic and irregular in shape) with much fibrous tissue. Muscular coat thickened and invaded by islands of tumor cells. Some invasions of the subserous layer. There are islands of fairly extensive colloid change.

The patient is shown because of the interest in the pathological specimen and the fact that temporary relief may be given in a condition

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of this type. It is well known that this disease tends to an overgrowth of fibrous tissue with a destruction of the cancer cells, so that in many instances lesions removed at autopsy fail to show any remaining cancer. This has led to the name *limitis plastica* being given the disease and there has been some discussion as to whether it is always of a malignant type. The best authorities are now inclined to the belief that such is the case. The prognosis in this case is, of course, exceedingly grave, but it will be interesting to note the extent of relief afforded by the overcoming of the pyloric obstruction even though a considerable amount of cancer tissue remains.

DR. CHARLES N. DOWD said that as a side issue it was also interesting to note that this patient, before coming under Doctor Hartwell's care, had been operated upon for appendicitis without exploration of the upper part of the abdomen. Of course most surgeons now usually examine the upper abdomen when the abdomen is opened for other cause. It is not always appreciated that this exploration can be made through the intramuscular incision of McBurney if the outer part of the rectus sheath is cut, as was recommended by Weir. The entire hand can then be introduced into the abdomen and the gall-bladder, the duodenum and the pyloric end of the stomach as well as the head of the pancreas can be carefully palpated. Such palpation reveals pathological conditions from time to time, and prevents such undiscovered development as this case showed.

DR. JOHN F. CONNORS remarked upon the extensive involvement of a stomach with carcinoma one would get sometime before any symptoms were shown. Last month a man seventy-two years of age was seen by him who had been perfectly well with no gastric symptoms until the morning when he was stricken with a sharp pain, which was diagnosed as a perforated gastric ulcer. At operation it was found that the stomach from the pylorus to almost the cardia was involved with carcinoma, and his first symptom was the perforation which occurred on the anterior wall.

ADENOMA OF HEPATIC FLEXURE OF COLON

DR. JOHN A. HARTWELL presented a man, aged thirty-seven years, who was admitted to Bellevue Hospital, 2nd Surgical Division, September, 1921, suffering from an acute intestinal obstruction. The relevant history extends over a period of two months, during which time he had suffered from irregular attacks of abdominal pain, increasing constantly, and on one attack had passed a large quantity of blood by rectum. He had grown progressively more ill with the loss of a considerable amount of weight. Intestinal obstruction had existed as complete for three days and fecal vomiting was present. An immediate laparotomy was done by the Resident Surgeon which disclosed a neoplasm at the hepatic flexure of the colon and an immediate cæcostomy was done. The cæcostomy functioned satisfactorily. He gained in weight and there was a recession of the obstruction as shown by the passage of some fecal matter per anum. After six weeks the radical removal

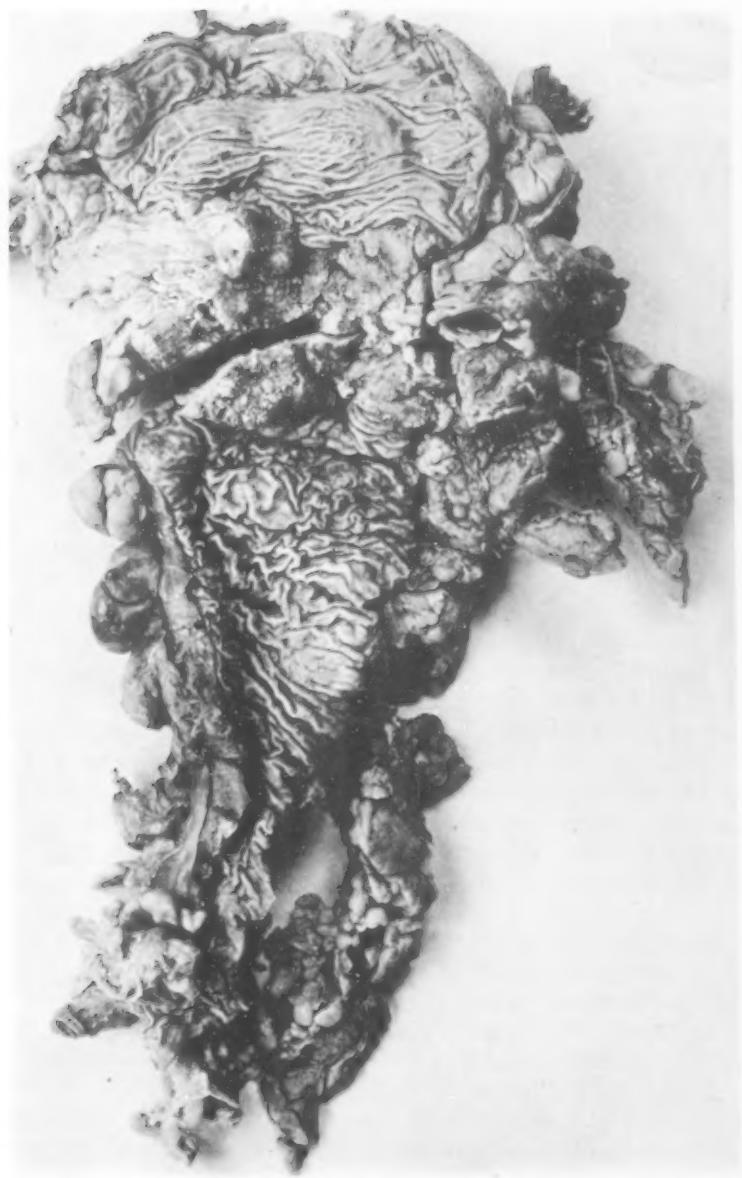
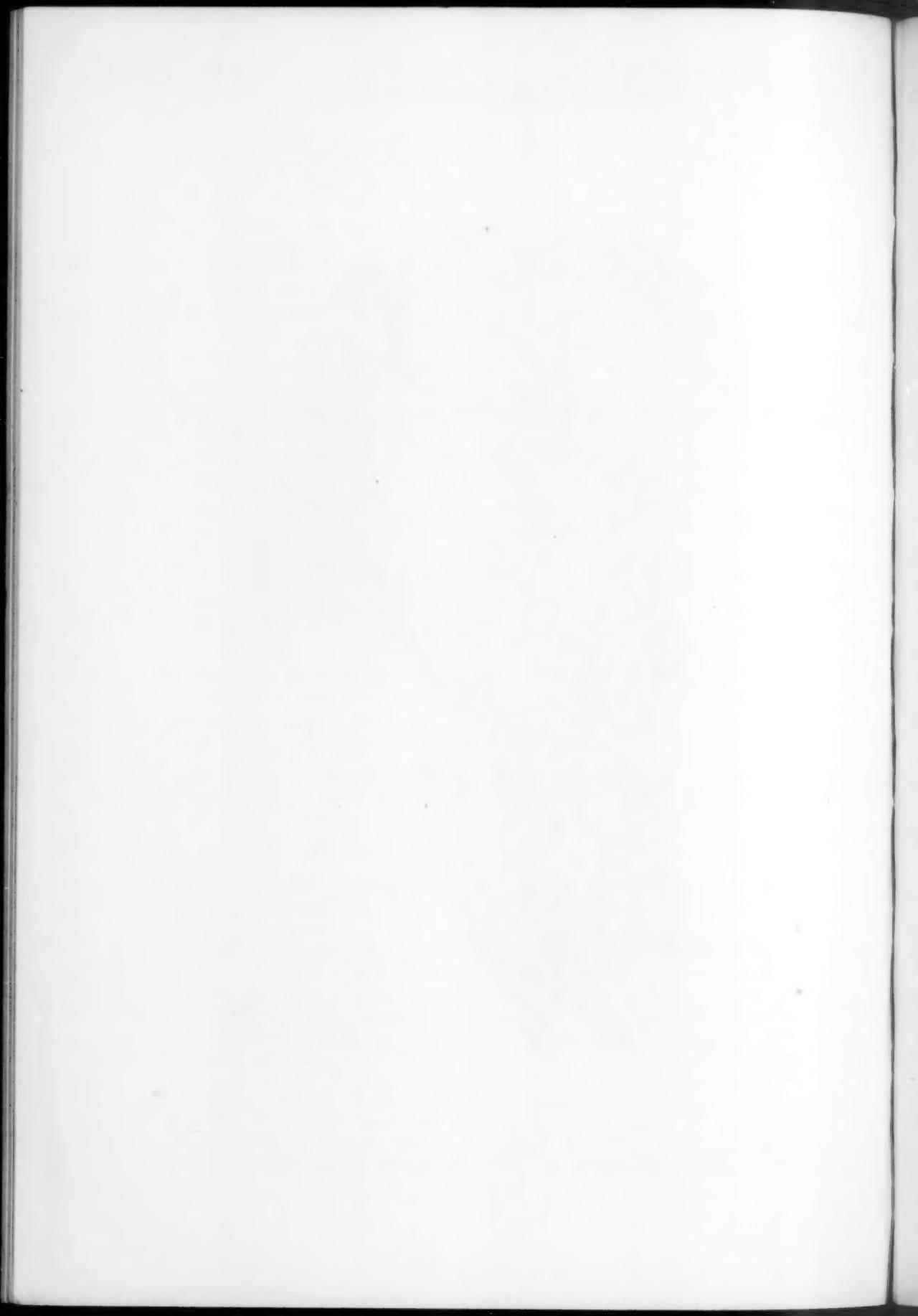


FIG. 2.—Adenoma destruens of hepatic flexure.



ADENOMA OF HEPATIC FLEXURE OF COLON

of the tumor was accomplished. The usual procedure was followed of mobilizing the ascending colon with the tumor mass at its flexure. A portion of the colon from just above the cæcum to the middle of the transverse colon, with all the draining lymphatic system, was removed. A lateral anastomosis was made between the ileum, five inches proximal to the ileocæcal valve, and the transverse colon. It was decided to leave the cæcum *in situ* for two reasons: First, that the presence of the cæcostomy wound made its removal an additional hazard, and second, because the cæcostomy would act as a safety opening in case of œdematous obstruction at the site of the anastomosis, a well-known complication of this operation. It was hoped the cæcostomy would close spontaneously. This hope was not realized, as there was a small amount of fecal leakage from time to time through this opening. Three months later, therefore, it was decided to close the cæcostomy opening. This was done by freeing it from the abdominal parietes, suturing the opening in the cæcum and covering it with two layers of peritoneum.

The question was raised as to whether the ileocæcal valve would be sufficiently competent to prevent whatever faeces got into the cæcum from being re-expelled toward the ileo-colostomy. It was decided that this probably would not be the case. This decision proved to be erroneous. At the end of twenty-four hours the cæcum was enormously distended. The site of suture ruptured and there was a discharge of a large amount of liquid faeces and gas. It was obvious that the ileocæcal valve had proved completely incompetent.

The following day the fourth operation was performed. The cæcum and segment of ileum up to the point of anastomosis with the colon was removed. The patient has made a good recovery. Wounds are healed and solid and his general condition is rapidly becoming normal. Exploration of the abdomen at the time of this operation failed to show any evidence of recurrence of the growth.

He presented this case because of the interest attaching to the competency of the ileocæcal valve. The procedure of using the cæcostomy as a safety outlet with the hope of spontaneous closure is a recognized one. So far as noted the case is unique in the way in which the valve complicated the situation.

Pathological report on the specimen removed by Bellevue Hospital Laboratory is as follows: Gross segment of colon about five inches long in the centre of which is a slightly elevated ulcerated area two square inches in size. This area is about one-half inch in thickness, moderately firm and whitish. There are one or two pea-sized nodes along the colon (Fig. 2). Microscopic: Section shows growth to consist of irregular alveoli of large hyperchromic epithelial cells. In some places the basement membrane is defective. Interstitial tissue slight in amount infiltrated with round cells and a few polymorphonuclears. Muscularis beneath growth not incised. Lymph-nodes show inflammatory hyperplasia. No evidence of malignancy.

DR. CHARLES N. DOWD referred to a method for securing a vent for possible intestinal accumulation as described by Dr. Charles Mayo (*Jour.*

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A. M. A., Sept. 9, 1916, vol. Ixvii, pp. 779-83). After removing the ascending colon an end-to-side union was made between the terminal ileum and the transverse colon. The purse-string suture in the proximal end of the transverse colon was so made that a vent could easily be secured through the abdominal wall.

THE DIAGNOSIS AND TREATMENT OF INCOMPLETE EPIPHYSEAL FRACTURES AT THE HIP

DR. ROYAL WHITMAN read a paper with the above title, for which see page 624. He also presented three patients, as follows:

CASE I.—A healthy boy eighteen years of age, first seen in September, 1920. About three months before he had fallen from a bicycle and afterward noticed some discomfort and stiffness about the right hip which had become practically disabling. In this case the limp was marked, as was the characteristic limitation of motion.

September 20, 1920. Under anaesthesia the restriction of motion was, in part, overcome and a plaster spica applied. A second attempt made in a week, and a third, a week later. On this occasion there was an audible yielding of the obstruction and a full range of motion was restored.

December 30, 1920. The plaster was removed and exercises begun. He had not been seen since, but a skiagraph showed his condition to be practically normal.

CASE II.—A healthy, well-developed girl twelve years of age, came to the hospital because of a limp and some discomfort in the left hip. There were the usual signs of slight outward rotation, and slight limitation of motion. First operation, September 16, 1920. Second operation, September 27, 1920. December 9, 1920, plaster removed. Complete recovery.

CASE III.—A rather fat boy. Was seen in November, 1921. He thinks he injured the right hip wrestling in April. Since then he has suffered increasing limp and discomfort. The deformity was reduced in November and the plaster spica finally removed the following April. He now has a full range of motion, but uses crutches.

FRACTURES IN CHILDREN—AN INVESTIGATION OF LATE RESULTS

DR. E. D. TRUESDELL read a paper with the above title.

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